APPENDIX

B

Biodiversity Technical Report

PART 6 OF 6

Appendix J

NORTH STAR TO NSW/QUEENSLAND BORDER ENVIRONMENTAL IMPACT STATEMENT

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

INLAND RAIL

APPENDIX B

Biodiversity Technical Report

Appendix J Adverse Impact Assessment Methodology

NORTH STAR TO NSW/QUEENSLAND BORDER ENVIRONMENTAL IMPACT STATEMENT

ARTC

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

Inland Rail: Phase 2 - North Star to NSW/QLD Border

Appendix J – Matters of National Environmental Significance Adverse Impact Assessment Methodology

Australian Rail Track Corporation

Reference: 2700

Contents

Appendices

Acronyms

Acronym	Definition
AIAM	adverse impact assessment methodology
BPA	biodiversity planning assessment
Cth	Commonwealth
DES	Department of Environment and Science (Qld)
DoEE	Department of Environment and Energy (Cth)
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities (Cth)
EHP	Department of Environment and Heritage Protection (Qld)
EIS	Environmental Impact Statement
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
km	kilometre
m	metre
MNES	matters of national environmental significance
the Project	NSW Border to Gowrie Inland Rail Project
Qld	Queensland
RE	regional ecosystem
SAVS	system for assessing vulnerability of species
TEC	threatened ecological community

Reporting context

This report presents an adverse impact assessment methodology (AIAM) that has been developed to identify areas where a Project action is considered likely to have a significant residual adverse impact on an *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) listed matters of national environmental significance (MNES). The AIAM has been designed to provide for a transparent, consistent, repeatable and defendable approach to assessing significant residual adverse impacts. Information inputs are sourced from published, peer-reviewed scientific literature, field validated data and expert opinion.

The AIAM is focused on EPBC Act listed species/communities and their habitat (i.e. MNES) that have been identified as having a moderate or higher significance of impact as determined by the initial impact assessment undertaken for the Project.

The Department of the Environment and Energy (DoEE) EPBC Act Environmental Offsets Policy defines offsets as "measures that compensate for the residual adverse impacts of an action on the environment" (DSEWPaC 2012).

The EPBC Act Environmental Offsets Policy (DSEWPaC 2012) states that 'environmental offsets' are measures that compensate for the **residual adverse impacts** of an action on the environment and defines **residual adverse impacts** as those impacts which remain after avoidance and mitigation measures have been implemented. The EPBC Act only requires residual adverse impacts to be offset if the impact is considered to be **'significant'** as defined by the 'Matters of National Environmental Significance – Significant Impact Guidelines Version 1.1' (DoEE 2013).

The purpose of the AIAM is to identify areas within a project footprint (in this case the North Star to Border (NS2B) Inland Rail footprint) where the proposal activities have resulted in a significant residual adverse impact to EPBC Act listed species and/or their associated habitat. An assessment ranking approach was used to develop an assessment matrix by which impacts could be ranked and reflected in a GIS model.

The AIAM uses five factors; including habitat suitability, habitat resilience, species resilience, landscape attributes and disturbance nature, in an assessment matrix to assess potential impacts of the proposal on the key elements which may result in a significant residual adverse impact to a specific MNES.

To acknowledge and reflect the EPBC Act significant impact assessment for MNES species in the adverse impact assessment matrix outputs, the significant impact criteria contained in the significant impact guidelines were built into the assessment matrix inputs. A summary of how the significant impact criteria (referenced in **bold** text) is reflected in the adverse impact assessment is provided below.

- **Lead to a long term decrease in the size of a population** – The species resilience input provides for an assessment of the species capacity to recover from disturbance whilst the habitat suitability provides for assessment of species important habitat and the landscape attribute assessment provides for reference to impacts on local fauna assemblages.
- **Reduce the area of occupancy of the species** – Habitat suitability input accounts for species area of occupancy and impacts to areas of important habitat.
- **Fragment an existing important population into two or more populations** – The connectivity assessment conducted as part of the landscape attribute assessment provides for an assessment of potential Project impact from fragmentation and the species resilience input provides for an assessment of the species capacity to colonise new areas and its reliance on habitat linkages.
- **Adversely affect habitat critical to the survival of a species** – Species resilience input provides assessment of a species capacity to respond to disturbances to breeding and non-breeding habitat, the habitat resilience input accounts for the capacity of a species habitat to respond to disturbance and the habitat suitability input provides for an assessment on areas of important habitat
- **Disrupt the breeding cycle of a population** – Species resilience input provides for an assessment of species resilience to breeding cycle disruptions.

- **Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline** – The landscape attribute assessment provides for an assessment of potential impacts on species habitat within proximity to the disturbance area by assessing Project impacts on the size of habitat patch, connectivity and habitat availability. The species resilience input provides for an assessment of a species capacity to respond to disturbances to breeding and non-breeding habitat. The habitat resilience input accounts for the capacity of a species habitat to respond to disturbance.
- **Result in invasive species that are harmful to MNES species becoming established in the MNES species' habitat** – Species resilience input assesses Project impact on invasive species and the species capacity to respond, including an assessment of the predation vulnerability of the target species.
- **Introduce disease that may cause the species to decline** – Species resilience input assesses Project impact on disease prevalence and the species capacity to respond.
- **Interfere with the recovery of the species** – Species resilience input provides for an assessment of the species capacity to recover from disturbance and the landscape attribute assessment provides for an assessment of the ability of the affected habitat patch to support the target species post disturbance.
- **Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species** – Species resilience input provides for an assessment of species capacity to respond to disturbances to breeding and non-breeding habitat, and the habitat resilience input accounts for the capacity of a species habitat to respond to disturbance. The landscape attribute assessment provides for an assessment of potential impacts on regionally available habitat by assessing impacts on the size of habitat patch, connectivity and habitat availability.
- **Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species** – Species resilience input assesses Project impact on invasive species and the species capacity to respond, including an assessment of the predation vulnerability of the target species.
- **Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species** – Species resilience input provides for an assessment of species ability to disperse and its capacity to respond to disturbances to breeding and non-breeding habitat and resource fluctuations.

To acknowledge and reflect the EPBC Act significant impact assessment for MNES threatened ecological communities in the adverse impact assessment matrix outputs, the significant impact criteria contained in the significant impact guidelines were built into the assessment matrix inputs. A summary of how the significant impact criteria (referenced in **bold** text) is reflected in the adverse impact assessment is provided below.

- **Reduce the extent of an ecological community** – Habitat suitability input accounts for species area of occupancy and impacts to areas of important habitat
- **Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines** – The connectivity assessment conducted as part of the landscape attribute assessment provides for an assessment of potential Project impact from fragmentation and the community's resilience input provides for an assessment of the species capacity to colonise new areas and its reliance on habitat linkages
- **Adversely affect habitat critical to the survival of an ecological community** – Species resilience input provides assessment of a community's capacity to respond to disturbances to habitat, the habitat resilience input accounts for the capacity of a community's habitat to respond to disturbance and the habitat suitability input provides for an assessment on areas of important habitat

- **Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns** – The landscape attribute assessment provides for an assessment of potential impacts on community's habitat within proximity to the disturbance area by assessing Project impacts on the size of habitat patch, connectivity and habitat availability. The species resilience input provides for an assessment of a community's capacity to respond to disturbances to habitat. The habitat resilience input accounts for the capacity of a community's habitat to respond to disturbance
- **Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting** – Species resilience input assesses Project impact of invasive species and the communities capacity to respond accordingly. The landscape attribute assessment provides for an assessment of potential impacts on community's habitat within proximity to the disturbance area by assessing Project impacts on the size of habitat patch, connectivity and habitat availability
- **Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: (a) assisting invasive species, that are harmful to the listed ecological community, to become established, or (b) causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community** – Species resilience input provides for an assessment of community's capacity to respond to disturbances to habitat, and the habitat resilience input accounts for the capacity of a community's habitat to respond to disturbance. The landscape attribute assessment provides for an assessment of potential impacts on regionally available habitat by assessing impacts on the size of habitat patch, connectivity and habitat availability
- **Interfere with the recovery of an ecological community** – Species resilience input provides for an assessment of the community's capacity to recover from disturbance and the landscape attribute assessment provides for an assessment of the ability of the affected habitat patch to support the target community post disturbance.

The AIAM includes an assessment of potential impacts of the proposal on recognised threatening processes for a threatened species which have resulted in the species threatened status and subsequent decline. As such, the degree of vulnerability of the target species to disturbance is captured in the Project assessments of species resilience to reflect the differing sensitivities that Endangered, Vulnerable or Migratory species have to disturbance.

The AIAM provides for the provision of a 'fatal flaw' trigger which identifies extreme risk factors that result in a significant residual adverse impact on the target species and/or their preferred habitat. The fatal flaw trigger captures scenarios were the level of risk to the species is too high, automatically resulting in an 'adverse impact' output. Where a fatal flaw is triggered, the proponent would be required to provide a suitable offset.

Areas of important habitat are captured in this adverse impact assessment as 'core habitat'. Core habitat represents an area of habitat in which the target species is known and the area of habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Core habitat also captures populations that are limited geographically within the region. As areas of core habitat represent important habitat for the target species, core habitat is allocated a fatal flaw to reflect the high ecological value of the habitat area.

This document presents the outcomes of the AIAM when applied to the Inland Rail feasibility design, to provide an indicative extent of significant residual adverse impact on EPBC Act listed species that have the potential to be impacted by the proposal.

1 Introduction

1.1 Background

The Australian Government has committed to delivering a significant piece of national transport infrastructure by constructing a high performance and direct interstate freight rail corridor between Melbourne and Brisbane, via central-west New South Wales (NSW) and Toowoomba in Queensland.

Inland Rail is a nationally significant transport initiative. Inland Rail will provide a high-capacity freight link between Melbourne and Brisbane through regional Australia to better connect cities, farms, and mines via ports to domestic and international markets.

The objectives of Inland Rail as a whole are to:

- Provide a link between Melbourne and Brisbane that is interoperable with train operations to Perth, Adelaide, and other locations on the standard gauge rail network, to serve future rail freight demand, and stimulate growth for inter-capital and regional/bulk rail freight
- Provide an increase in productivity that will benefit consumers through lower freight transport costs
- Provide a step-change improvement in rail service quality in the Melbourne to Brisbane corridor and deliver a freight rail service that is competitive with road
- Improve road safety, ease congestion, and reduce environmental impacts by moving freight from road to rail
- Bypass bottlenecks within the existing metropolitan rail networks, and free up train paths for other services along the coastal route
- Act as an enabler for regional economic development along the Inland Rail corridor.

Inland Rail will enhance Australia's existing rail network and serve the interstate freight market by delivering a road competitive service that will see freight delivered from Melbourne to Brisbane, in less than 24 hours with reliability, pricing and availability that is equal to or better than road. Inland Rail provides a step-change in freight productivity, while also catalysing a range of potential benefits from complementary investments in land use and supply chains that leverage the enhanced logistics capabilities of Inland Rail.

The Inland Rail route will be approximately 1,700 kilometres (km) in length, including 1,200 km of enhanced and upgraded tracks and 500 km of new greenfield sections via regional Victoria, NSW and Queensland. Where possible, existing rail infrastructure will be used to minimise the environmental and community impacts associated with creating new rail corridors.

This adverse impact assessment methodology contained in this report is specific to the North Star to NSW/QLD Border (NS2B) (henceforth referred to as "the proposal") which is the northern most NSW section of the Inland Rail alignment.

1.2 Purpose and scope

This report has been prepared to consolidate existing and collate additional data, to ascertain the degree of the Project's impact on EPBC Act listed species (and associated habitats) (i.e. MNES species) subject to disturbance from the Project.

An investigation of all MNES species (i.e. flora, fauna and threatened ecological communities (TECs) as necessary) and their associated habitat's resilience to disturbance was conducted via review of published, peer-reviewed scientific literature. This investigation identified MNES species that are considered to be disturbance tolerant or disturbance specialists and habitat areas that are considered to represent disturbance resilient habitat.

To provide for a transparent, consistent and repeatable approach to assess species resilience, a scoring system was developed to rank species in order of their resilience using a set of defined criteria. The scoring system was informed by the ‘system for assessing vulnerability of species (SAVS)’ (Bagne et al. 2011) which was developed to assess the relative vulnerability, or resilience, of a species to the potential effects of climate change. The species resilience questionnaire which was completed for each MNES species is discussed in further detail in Section 2.3, with results for each species presented in Appendix B.

Habitat resilience was defined by the natural regeneration time associated with each key vegetation community which occurs within the Project construction and operational footprint. Habitat resilience is discussed in further detail in Section 2.4.

The potential impact of the proposal’s disturbance on regionally availably habitat for each species was assessed via a landscape attribute assessment which provided for assessment of three key landscape attributes; including size of habitat patch, habitat connectivity and habitat context. The assessment of landscape attributes is described in further detail in Section 2.5.

Using the results from the assessments of species resilience, habitat resilience and landscape attributes together with the habitat category identified for the species at the location of works (i.e. core, essential, general or unlikely habitat as defined in Appendix A of the Biodiversity Technical Report (i.e. Predictive Habitat Modelling Methodology), an assessment matrix was developed to provide a consistent, transparent and repeatable method by which the proposal’s impacts to MNES species could be ranked and reflected in a GIS model. The habitat category input is based on ecological ground-truthed mapping and habitat assessments conducted within the subject land.

The assessment matrix predicted when an impact was considered to be a residual adverse impact which is significant to a MNES species. The assessment methodology is detailed in Section 2.

1.3 Project background

1.3.1 Description of Project works

The Australian Government has committed to delivering Inland Rail, an interstate freight rail corridor between Melbourne and Brisbane, via central-west New South Wales and Toowoomba in Queensland. Inland Rail is a significant piece of nation transport infrastructure. It will enhance Australia’s existing rail network and serve the interstate freight market.

The Inland Rail route, which is approximately 1,700 kilometres (km) long, will involve:

- Using the existing interstate rail corridor through Victoria and southern NSW
- Upgrading approximately 400 km of existing corridor, mainly in western NSW
- Providing approximately 600 km of new corridor in northern NSW and southeast QLD.

Inland Rail has been divided into thirteen sections, seven of which are located in NSW.

In 2015, Australian Rail Track Corporation (the proponent) developed a ten-year programme to deliver Inland Rail by 2025. ARTC was created in 1997 after the Australian and State governments agreed to the formation of a ‘one stop shop’ for all operators seeking access to the national interstate rail network. The proponent is seeking approval to construct and operate the North Star to NSW/QLD border section of Inland Rail (the proposal). The proposal consists of approximately 25 km of upgraded track between North Star and a greenfield deviation around Whalan Creek, and 5 km of new track between Whalan Creek and the NSW/QLD border. The proposal is a key component of the wider Inland Rail network between Melbourne and Brisbane.

1.3.2 Key project features

The proposal consists of the key features listed in Table 1.1. The construction phase of the proposal will also involve laydown areas, temporary access tracks, borrow bits, a mobile concrete batching plant, and a construction camp.

Table 1.1 Key features of the proposal

Aspect	Description
New track	▪ Approximately 25 km of new track within the existing, non-operational Boggabilla rail corridor ▪ Approximately 5 km of new track within a greenfield rail corridor
Crossing loop and turnouts	▪ One crossing loop, designed to accommodate trains up to 1,800 m long, with provisions to accommodate trains up to 3,600 m long if required in the future ▪ Turnouts will be provided on either end of the crossing loop to allow trains to be guided from one track to another
Bridges	▪ Eleven new bridges ▪ This includes an approximately 1.8 km long viaduct over the Macintyre River and Whalan Creek, which are major watercourses. The viaduct is located in both NSW and QLD; therefore, it will be assessed under *the NSW Environmental Planning and Assessment Act 1979* (EP&A Act) by this EIS, and under the *State Development and Public Works Organisation Act 1971* by the NSW/QLD border to Gowrie EIS. Approval from both States is required before construction of the viaduct can commence.
Drainage	▪ Reinforced concrete pipe culverts and reinforced concrete box culverts. Scour protection measures will generally be installed around culverts to avoid erosion. ▪ Embankment and catch drains adjacent to the proposed alignment to divert surface runoff the nearest bridge or culvert location
Level crossings	▪ Work on new and existing level crossings ▪ Signalling and communications infrastructure
Ancillary works	▪ Ancillary infrastructure including signalling and communications infrastructure, signage, fencing and utilities.

1.3.3 Descriptions of key features of the proposal

1.3.3.1 Permanent footprint

The proposal is generally in accordance with the following parameters:

- Generally, aligns with the existing, non-operational Boggabilla rail corridor between North Star (Ch0 0.9 km) and the greenfield deviation (Ch 25.7 km)
- A strip of land at least 10 m wide has been allowed on either side of the earthworks footprint to accommodate track-side infrastructure such as fencing, drainage, etc.
- Encompasses the ultimate footprint of:
  - New track and associated earthworks
  - Bridge and drainage structures, including scour protection around culverts
  - Level crossings
  - Road realignments
  - Possible upgrades to adjacent roads and infrastructure
  - Rail maintenance access road, including access points, passing bays and turnarounds
  - Fencing and signage.

The width of the permanent footprint varies along the proposed alignment depending on the shape and size of the features listed above. A minimum width of 40 m has been adopted for the permanent footprint; however, the width of the permanent footprint increases to approximately 200 m in the vicinity of the Bruxner Way realignment.

1.3.3.2 New track

Track within the existing, non-operational Boggabilla rail corridor is considered unsuitable for reuse. Therefore, the proposal consists of:

- Approximately 25 km of new, single line, standard gauge track within the existing, non-operational Boggabilla rail corridor, between North Star (Ch 0.9 km) and the greenfield deviation (Ch 25.7 km)
- Approximately 5 km of new, single line, standard gauge track within a greenfield rail corridor, between the greenfield deviation (Ch 25.7 km) and the NSW/QLD border (Ch 30.6 km).
- Key features of the new track include:
- Single line – trains travelling in both directions share the same track
- Standard gauge – gauge refers to how far apart the rails on a railway track are spaced. Standard gauge indicates that the rails will be spaced 1.435 m apart
- Greenfield rail corridor – this is a section of new track within a new rail corridor.

The track structure will consist of rails, fasteners, rail pads and concrete sleepers, which are laid on a trackbed of ballast. Collectively, these elements are referred to as ‘permanent way’.

The new track is designed to support 21 tonne axle load intermodal (i.e. container) trains up to 1,800 m long and 6.5 m high. Tonne axle load refers to the total weight felt by the track due to passing trains. Depending on the tonne axle load, train speeds will vary between 80 kilometres/hour (km/hr) and 115 km/hr.

1.3.3.3 Crossing loop and maintenance siding

The proposal includes one crossing loop, known as the Boonal crossing loop. As the proposal is for single line track, the Boonal crossing loop will allow trains travelling in opposite directions to pass each other.

The Boonal crossing loop is an approximately 2.2 km section of single line, standard gauge track, running roughly parallel to the main track. The optimised location of the crossing loop is between Ch 22.7 km and Ch 24.9 km. During the feasibility design phase, the location of the crossing loop was chosen on account of following factors:

- Operational modelling undertaken by ARTC for the wider Inland Rail Programme demonstrated that installing a crossing loop in this location would minimise train travel times in both directions
- Placing the crossing loop in this location minimises construction works as it is a relatively straight section of track, clear of structures and level crossings.

The Boonal crossing loop is able to accommodate trains up to 1,800 m long, with provisions to accommodate trains up to 3,600 m long if required in the future. It is connected to the main track at both ends via low-speed (80 km/hr) turn outs.

A one-ended, single line, standard gauge siding will be incorporated into the Boonal crossing loop for maintenance purposes. It is approximately 500 m long and will be connected to the southern end of the Boonal crossing loop via a low-speed (40 km/hr) turn out. Connecting to the southern end is preferred over the northern end due to the straighter, flatter alignment, and lower embankment heights.

1.3.3.4 Bridges

Bridges are required so that water, vehicles, and in some cases, stock and pedestrians may cross the proposed rail corridor. Two types of bridges are proposed:

- Rail over water
- Rail over road.

The type of bridge proposed depends on a range of factors, including the local topography, road usership, rail and road alignments at the crossing point, and access requirements. Bridges have been provided at all major watercourse crossings along the proposed alignment to minimise impacts to the local riverine system, and to avoid having to divert watercourses.

A total of 11 new bridges are proposed. An approximately length for each bridge is included in Table 1.2.

Table 1.2 Proposed bridges

Chainage of the southern-most end of the bridge (km)	Bridge	Approximate bridge length
Ch 5.7	Mobbindry Creek Rail Bridge	112 m
Ch 6.1	Mobbindry Floodplain Rail Bridge	182 m
Ch 8.1	Back Creek Rail Bridge	70 m
Ch 16.3	Forest Creek Rail Bridge	154 m
Ch 20.7	UT1 Forest Creek Rail Bridge	136 m
Ch 25.2	Melonenkamm Rail Bridge	160 m
Ch 25.7	Bruxner Way Rail Bridge	114 m
Ch 26.0	Whalan Floodplain #1 Rail	183 m
Ch 27.5	Whalan Floodplain #2 Rail	126 m
Ch 27.5	Whalan Floodplain #3 Rail	126 m
Ch 29.3	Macintyre River Viaduct	1,750 m

1.3.3.5 Macintyre River viaduct

The includes an approximately 1.8 km long viaduct that crosses Whalan Creek, Tucka Tucka Road and the Macintyre River. Approximately 1.2 km of the viaduct is located in NSW, while the remaining 0.5 km is located in Queensland, where the NSW/QLD border is defined by the centre point of the Macintyre River.

During the feasibility design phase, the design of the Macintyre River Viaduct was informed by geotechnical and flooding studies. Initially, three separate bridge structures were proposed over Whalan Creek, Tucka Tucka Road, and the Macintyre River. However, an iterative flood assessment of the design has resulted in a single viaduct structure that minimises upstream flooding impacts.

1.3.3.6 Culverts

Culverts are structures that allow water, whether in a watercourse or drainage line, to pass under the proposed alignment. During the feasibility design phase, proposed designs and locations for culverts were developed based on:

- Addressing hydrologic, hydraulic and geotechnical constraints associated with the proposal
- Minimising potential flooding impacts by:
- Locating culverts at low points along the proposed alignment in order to prevent upstream water ponding
- Ensuring that the inside base of culverts is level with the natural surface

- Designing culverts to withstand a 100 year flood event (i.e. 1% annual exceedance probability (AEP)
- Maintaining existing patterns of flow across the floodplain so as not to divert or concentrate flows.

Culverts associated with the proposal will be a mix of reinforced concrete pipe culverts and reinforced concrete box culverts. Scour protection measures will generally be installed around culverts, on disturbed stream banks, and around waterfront land to avoid erosion.

A total of 48 culvert locations were identified during the feasibility design phase. The number of culverts and their locations will be further refined during the detailed design phase in order to minimise potential impacts, especially flooding impacts.

1.3.3.7 Road rail interfaces

Road rail interfaces are points at which the proposed alignment intersects a road. Treatments for road rail interfaces can be categorised as grade separated crossings, level crossings or closures:

- **Grade separated crossings** – road and rail cross each other at different heights so that traffic flow is not affected. Grade separations are either road over rail, or rail over road.
- **Level crossings** – road and rail cross each other at the same level. Level crossings have either passive or active controls to guide road users:
- **Passive** – have static warning signs (e.g. stop and give way signs) that are visible on approach. This signage is unchanging with no mechanical aspects or light devices.
- **Active** – have static warning signs as well as flashing lights and automatic boom gates
- **Closure** – existing road rail interfaces may be closed, consolidated into fewer crossing points, relocated or diverted to where there is lower operational demand. Closures will only occur where the impact of diversions or consolidations is considered acceptable, or the existing location is not considered safe and cannot reasonably be made safe.

There are no existing signalling or communications systems within the proposed alignment. New signalling and communications infrastructure will be installed at the crossing loop and active level crossings, enabling active controls to tie into the wider Inland Rail network.

In the future, ARTC's Advanced Train Management System is proposed to manage signalling and communications for the wider Inland Rail network. Communication (voice and data) will occur between Network Control Centres and locomotives operating on the Inland Rail network.

1.3.3.8 Road realignments

The proposal involves a minor realignment of Bruxner Way. Bruxner Way is a Main Road pursuant to the *Roads Act 1993*. It is a two lane, two-way road with a posted speed limit of 100 km/hr.

In order to achieve flood immunity, the elevation of the proposal must be significantly higher than Bruxner Way at the point where the proposal intersects Bruxner Way. Therefore, a rail over road grade separation with a minimum vertical clearance of 5.4 m is proposed at the point of intersection.

At the point where the proposal intersects the existing Bruxner Way, the skew angle is approximately 75 degrees. Maintaining this skew angle would involve constructing a bridge with excessively long, non-standard spans.

A more practical skew angle is 45 degrees. To achieve a 45-degree skew angle, it is proposed to realign Bruxner Way to the east, and then back to the existing Bruxner Way on a slight curve.

As part of the reconfiguration, the elevation of Bruxner Way will be maintained or slightly increased. This will maintain or improve flood immunity at this location.

1.3.3.9 Earthworks

The proposed alignment traverses the Macintyre River floodplain for approximately 14 km. To achieve flood immunity, the majority of the proposal is elevated on a fill embankment. The embankment height is typically less than 2 m; however, around the realigned Bruxner Way and in the lead up to the Macintyre River Viaduct, the embankment height increases to approximately 7.5 m.

Embankments have been designed and constructed to minimise erosion during flood events. The steepness of embankments will be minimised as much as possible to encourage vegetation growth, which will further prevent erosion.

No significant cuttings (i.e. > 10 m deep) are proposed. However, where practicable, materials won from excavations and cuttings will be assessed for re-use as embankment fill. If unsuitable for reuse, this material may be formed into permanent spoil mounds within the rail corridor. Features of the spoil mounds include:

- Located as close as possible to the source of excavated material
- Maximum height of 2 m
- May be located on both sides of the track
- Would be stabilised as required
- Gaps in the spoil mounds would be provided to allow water to drain away from the track.

The exact location, sizing and design of spoil mounds will be determined during the detailed design phase, with consideration given to the results of hydraulic modelling and sight distances. Mounds would not be located in areas where they would impact on flooding or drainage.

1.3.4 Fencing and signage

The purpose of fencing is to protect the proposed alignment from trespass and prevent stock on adjoining properties from accessing the rail corridor. Standard rural fencing, consistent with the existing rural landscape, is proposed between the rail corridor and adjoining properties, generally located at the corridor boundary.

Fencing will generally be provided around culverts. Gates will be installed for accessing culverts for inspection and maintenance.

Fencing will continue to bridge abutments. However, to avoid locating fencing in major watercourses and floodplains, the rail corridor will not be fenced underneath bridges. In specific cases, fencing will be provided across waterways to prevent stock on adjoining private properties from accessing the rail corridor.

Signage is also proposed, especially at level crossings.

1.3.5 Operation of the proposal

Subject to approval of the proposal, construction of the proposal is planned to occur between early-2021 and mid-2023. The proposal will be managed and maintained by the proponent; however, train services will be provided by a variety of operators. Train services are expected to commence in 2023, once construction is complete. Significant increases in train numbers are not expected until all 13 sections of Inland Rail are complete, which is planned to be in 2015.

The proposal will be trafficked by an estimated 12 trains per day in 2025, increasing to an estimated 21 trains per day in 2040 (refer Figure 1.1). Annual freight tonnages will increase in parallel, from approximately 12 million tonnes per year in 2025 to 20 million tonnes per year in 2040.

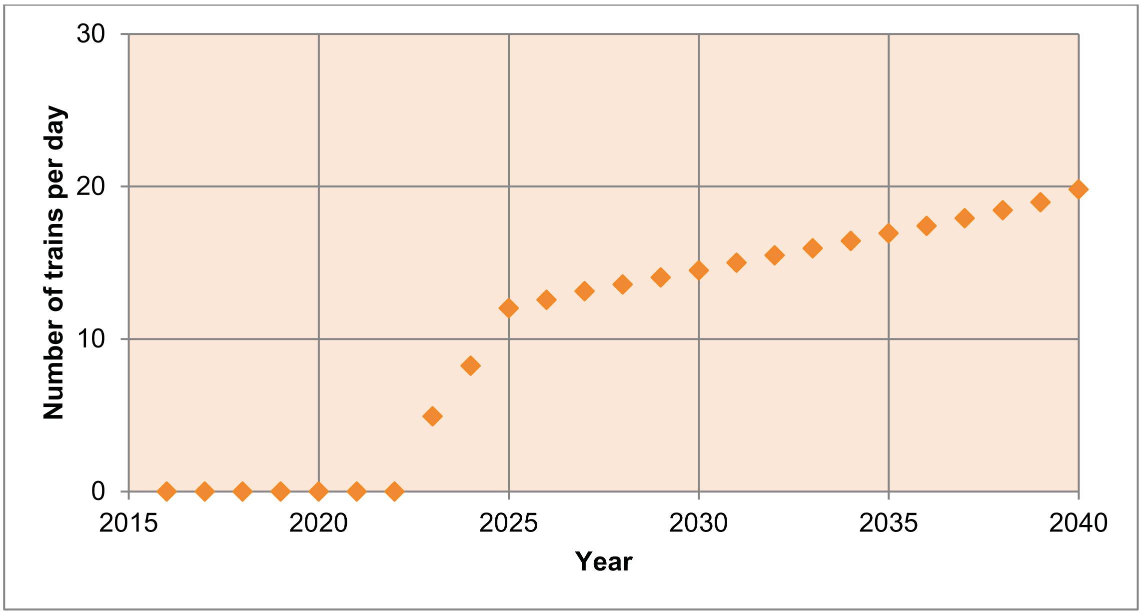


Figure 1.1 Projected growth in train numbers for Inland Rail

1.3.6 Maintenance of the proposal

During the operation phase standard maintenance activities will be undertaken, including:

- Bridge and culvert inspections
- Sleeper replacement
- Rail welding and grinding
- Ballast dropping and cleaning
- Track tamping and reconditioning

It is anticipated that pre-construction planning and land acquisition for the Project will occur from 2019 until late 2020. Construction of the Project is scheduled from 2020 to 2024, with operation in 2025.

The construction program defines a number of stages and activities. These comprise:

- Site preparation including:
  - Site clearance
  - Establishment of site compounds and facilities
  - Installation of temporary and permanent fencing
  - Installation of drainage and water management controls
  - Construction of site access including temporary haul roads
- Civil works including:
  - Bulk earthworks
  - Construction of cuts and embankments
  - Installation of permanent drainage controls
  - Bridge and watercourse crossing construction
  - Road works and rail interface crossings
- Track works including the installation of ballast, sleepers and rails

- Rail systems infrastructure and wayside equipment including signals, turnouts and asset monitoring infrastructure
- Commissioning, integration testing and handover process to achieve operational readiness.

1.4 Environmental offset requirements

The 'EPBC Act Environmental Offsets Policy' (DSEWPaC 2012) states that 'environmental offsets' are measures that compensate for the **residual adverse impacts** of an action on the environment and defines **residual adverse impacts** as those impacts which remain after avoidance and mitigation measures have been implemented. The EPBC Act only requires residual adverse impacts to be offset if the impact is considered to be **'significant'** as defined by the 'Matters of National Environmental Significance – Significant Impact Guidelines Version 1.1' (DOTE 2013).

The potential impacts on EPBC Act listed threatened and migratory species habitats informed by the feasibility design are contained in the Biodiversity Technical Report. Impacts associated within the following habitat categories have been determined where relevant:

- Core habitat
- Essential habitat
- General habitat
- Unlikely habitat.

The assessment methodology presented in this report has been prepared to identify the potential **significant residual adverse impacts** to the MNES species and/or their habitat values based on the feasibility design included with the Project EIS.

The AIAM provides for the provision of a 'fatal flaw' trigger which identifies extreme risk factors that result in a significant residual adverse impact on the target species and/or their preferred habitat. The fatal flaw trigger captures scenarios were the level of risk to the species is high. Where a fatal flaw is triggered, there is a significant residual adverse impact and these have been outlined in the Project EIS as potential indicative areas where ARTC will be required to provide a suitable offset for this MNES. The location and management of the associated offset/s will be detailed within the Project offset strategy.

2 Assessment methodology

The EPBC Act Environmental Offsets Policy outlines the Commonwealth Government's approach to the use of offsets under the EPBC Act. The policy defines offsets as *measures that compensate for the residual adverse impacts of an action on the environment* (DSEWPaC 2012).

As discussed in Section 1.2, the purpose of this document is to identify areas within the subject land where the proposal's activities will (and will not) result in a significant residual adverse impact to MNES species populations and/or their associated habitat subject to the proposal's EPBC Act obligations. To identify such areas, an assessment ranking approach was used to develop an assessment matrix to provide a consistent, transparent and repeatable method by which impacts of the proposal to MNES species could be ranked and reflected in a GIS model. The structure and implementation of the assessment ranking approach and assessment matrix were influenced by risk assessment theory and application.

To align with the EPBC Act controlled action, the assessment matrix which determines the nature of the Project's impact to each MNES species is an assessment of residual adverse impact. All assumptions and assessment criteria being used are based on scientific literature backed information.

To assess the nature (adverse or not adverse) and extent (significant or not significant) of a proposal impact on a MNES species, the following five key factors, or inputs, were identified:

- Habitat suitability
- Species resilience
- Habitat resilience
- Landscape attributes
- Disturbance nature.

The key factors above, have been ranked and modelled for this AIAM for the land in which the proposal is to occur.

The ranking system includes the provision of a 'fatal flaw' trigger. Fatal flaw triggers have been built into the assessment matrix to identify extreme risk factors that automatically result in a significant residual adverse impact on the target species and/or their preferred habitat.

To provide for rank standardisation, a number of fields and numerical values were assigned to each key factor subject to this AIAM to ensure robustness to the ranking system. To allow for a quantitative assessment output that could be modelled in GIS, numerical values were assigned to habitat suitability, species resilience, habitat resilience, landscape attributes and disturbance nature.

The numerical values which were allocated to the assessment are:

- 1 – Representing the low extremity of the key factors impact.
- 120 – Representing the high extremity of the key factors impact. This value was also allocated to represent a 'fatal flaw' trigger.
- 35 – Representing a moderate impact. The value 35 was chosen to provide for a wide values range to easily distinguish between ranking categories. To account for cumulative impacts and provide for a conservative measure of impact with respect to the precautionary principle which governs the EPBC Act, if three of the four key factors are attributed a moderate score, and the remaining attribute was allocated a low score (which would total 106), an adverse impact would still be triggered. Two moderate impact values when combined with two low values (72) is not considered to constitute an adverse impact with respect to the resilience represented in the balance of the remaining attributes which were allocated a low score.

A number of assessment scenarios were conducted to assess the outputs of the AIAM. The output scenarios were assessed by suitably qualified ecologists and included extensive reviews of scientific literature documenting the species ecological requirements. This review was done to determine if the resultant AIAM output values aligned with expert observation regarding the level of impact and the likelihood of species survival.

Following this detailed and extensive review process the combination of three moderate impact values when combined with one low value was considered the trigger for a significant residual adverse impact. Impacts to two key factors were not considered to have a significant residual adverse impact on the target species due to the resilience remaining in the other two factors. For example, moderate impacts to 'landscape attributes' (which represent attributes such as habitat connectivity and patch size) and 'habitat suitability', (e.g. an area of essential habitat where a species has been previously identified), were not considered to have a significant residual adverse impact on a highly resilient species (i.e. one with high mobility), which is associated with highly resilience habitat types.

However, scenarios also presented where impacts to three key factors were considered to have a significant residual adverse impact on the target species. For example, for an area of general habitat (i.e. 'habitat suitability' score of 1) for a moderately resilient species which is associated with a moderately resilient habitat type, with moderate impacts attributed to 'landscape attributes' was considered to be subject to significant residual adverse impacts. A precautionary approach was taken, with the assumption made that impacts to the combination of a moderately resilient species, moderately resilient habitat type and moderate impacts to the key landscape attributes (i.e. connectivity and patch size) would compromise the resilience of the system and therefore the species, to respond to disturbance.

The 'fatal flaw' trigger was built into the AIAM to capture factors which would have a significant residual adverse impact on a species, regardless of degree of impacts to the other key factors subject to the AIAM. For example, impacts to a low resilient species was considered to constitute a significant residual adverse impact regardless of the degree of impact to the species 'habitat suitability', 'habitat resilience' or 'landscape attributes'.

The application of the numerical values in the assessment process is discussed in further detail in the sections below, with a worked example of the assessment matrix for two species scenarios provided in Table 2.15.

The assessment matrix has been designed to determine whether a threshold for a key factor is likely to be triggered by activities related to the proposal, with a resultant consequence of a significant residual adverse impact. Section 5 of the EPBC Act Environmental Offsets Policy discusses the assessment stage which is implemented to determine whether an offset is necessary, one key step of which is the assessment of the residual adverse impacts to MNES and if the residual impacts are likely to constitute a 'significant impact' as defined in the 'Matters of National Environmental Significance – Guidelines Version 1.1' (DOTE 2013).

To acknowledge and reflect the EPBC Act significant impact assessment for MNES species in the assessment matrix outputs, the significant impact criteria contained in the guidelines were built into the assessment matrix inputs. Table 2.1 presents the DOTE (2013) significant impact criteria for critically endangered, endangered, vulnerable and migratory species, and notes how the criteria is reflected in the assessment.

Table 2.1 Incorporation of significant impact criteria for threatened and migratory species

Significant impact criteria	Assessment matrix input
Lead to a long term decrease in the size of a population	**Species resilience** (Q1 to Q12) – Provides for assessment of the species capacity to recover from disturbance **Habitat suitability** – Provides for assessment on species important habitat **Landscape attributes** – Provides for reference to impacts on local fauna assemblages
Reduce the area of occupancy of the species	**Habitat suitability** – Accounts for species area of occupancy by reflecting the category of habitat present for the species (i.e. 'core', 'essential', 'general')

Significant impact criteria	Assessment matrix input
Fragment an existing important population into two or more populations	**Landscape attributes –** The connectivity assessment conducted as part of the landscape attribute assessment provides for assessment of potential project impact on fragmentation **Species resilience** (Q5 – Q6) – Provides for assessment of the species capacity to colonise new areas and its reliance on habitat linkages
Adversely affect habitat critical to the survival of a species	**Species resilience** (Q1 to Q4) – Provides for assessment of species capacity to respond to disturbances to breeding and non-breeding habitat **Habitat resilience** – Accounts for the capacity of a species habitat to respond to disturbance **Habitat suitability** – Provides for assessment on species important habitat
Disrupt the breeding cycle of a population	**Species resilience** (Q8) to Provides for assessment of species resilience to breeding cycle disruptions
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Species resilience** (Q1 to Q4) – Provides for assessment of species capacity to respond to disturbances to breeding and non-breeding habitat **Habitat resilience** – Accounts for the capacity of a species habitat to respond to disturbance **Landscape attributes** – Provides for assessment of potential impacts on species habitat within proximity to the disturbance area by assessing project impacts on the size of habitat patch, connectivity and habitat availability.
Result in invasive species that are harmful to MNES species becoming established in the MNES species' habitat	**Species resilience** (Q10, Q12) – Assesses Project impact on invasive species and the species capacity to respond, including an assessment of the predation vulnerability of the target species
Introduce disease that may cause the species to decline	**Species resilience** (Q11) – Assesses Project impact on disease prevalence and the species capacity to respond
Interfere with the recovery of the species	**Species resilience** (Q1 to Q12) – Provides for assessment of the species capacity to recover from disturbance **Landscape attribute assessment** - Provides for assessment of the ability of the affected habitat patch to support the target species post disturbance
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	**Species resilience** (Q1 to Q4) – Provides for assessment of species capacity to respond to disturbances to breeding and non-breeding habitat **Habitat resilience** – Accounts for the capacity of a species habitat to respond to disturbance **Landscape attribute assessment** - Provides for assessment of potential impacts on regionally available habitat by assessing impacts on the size of habitat patch, connectivity and habitat availability
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	**Species resilience** (Q10, Q12) – Assesses Project impact on invasive species and the species capacity to respond, including an assessment of the predation vulnerability of the target species
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species	**Species resilience** (Q1 to Q9) – Provides for assessment of species ability to disperse and its capacity to respond to disturbances to breeding and non-breeding habitat and resource fluctuations

Table 2.2 Incorporation of significant impact criteria for threatened ecological communities

Significant impact criteria	Assessment matrix input (refer Appendix B for detailed community descriptions and AIAM questions identified below)
Reduce the extent of an ecological community	**Habitat suitability** – Accounts for community's area of occupancy by reflecting the category of habitat present (i.e. 'general habitat') **TEC's resilience** (Q2) – Provides for assessment for a reduction in area as a result of the project
Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines	**Landscape attributes** – The connectivity assessment conducted as part of the landscape attribute assessment provides for assessment of potential project impact on fragmentation **TEC's resilience** (Q5 – Q6) – Provides for assessment of the community's capacity to recolonise colonise following disturbance
Adversely affect habitat critical to the survival of an ecological community	**TEC's resilience** (Q1 – Q3) – Provides for assessment of community's capacity to respond to disturbances to habitat **Habitat resilience** – Accounts for the capacity of a species habitat to respond to disturbance **Habitat suitability** – Provides for assessment on species important habitat
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns	**TEC's resilience** (Q1 – Q3, Q5) – Provides for assessment of the community's capacity to respond to disturbances to habitat and resource availability **Habitat resilience** – Accounts for the capacity of a species habitat to respond to disturbance **Landscape attributes** – Provides for an assessment of potential impacts on community's habitat within proximity to the disturbance area by assessing Project impacts on the size of habitat patch, connectivity and habitat availability.
Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting	**TEC's resilience** (Q1, Q3, Q5, Q8) – Provides for assessment assesses Project impact on change including weed invasion and habitat disturbance **Landscape attributes** – Provides for an assessment of potential impacts on community's habitat within proximity to the disturbance area by assessing Project impacts on the size of habitat patch, connectivity and habitat availability. **Habitat resilience** – Accounts for the capacity of a species habitat to respond to disturbance habitat
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: (a) assisting invasive species, that are harmful to the listed ecological community, to become established, or (b) causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community	**TEC's resilience** (Q1 – Q3, Q5, Q7, Q8) – Provides for assessment of species capacity to respond to disturbances to habitat and weed invasion/disease **Habitat resilience** – Accounts for the capacity of a species habitat to respond to disturbance **Landscape attributes** – Provides for an assessment of potential impacts on community's habitat within proximity to the disturbance area by assessing Project impacts on the size of habitat patch, connectivity and habitat availability. **Habitat suitability** – Provides for assessment on species important habitat
Interfere with the recovery of an ecological community	**TEC's resilience** (Q1, Q2, Q3, Q7, Q8) – Provides for assessment of community's capacity to respond to disturbances to habitat **Landscape attributes** – Provides for an provides for an assessment of the ability of the affected habitat patch to support the target community post disturbance.

To ensure that the adversely impacted areas are captured, the assessment methodology assesses impacts of the proposal to the target species at the time of disturbance, which is the point in which the greatest impact to the species is anticipated (i.e. directly after habitat removal or modification).

The sections below discuss the assessment methodology in further detail and presents information regarding the species subject to the assessment, the five key factors; habitat suitability, species resilience, habitat resilience, landscape attributes and disturbance nature, by which the level of adverse impact was determined for each MNES fauna species and the ranking process by which the key factors were assessed.

2.1 Matters of national environmental significance species subject to assessment

The assessment was conducted for each MNES identified as having a high or greater level of impact significance as determined by initial impact assessment following the application of project mitigation measures. The species and communities, and their EPBC Act conservation status are defined in Table 2.3.

Table 2.3 Matters of national environmental significance terrestrial species subject to the assessment

Species name	EPBC Act status
Threated Ecological communities (TECs) - 4	
Brigalow (*Acacia harpophylla* dominant and co-dominant)	Endangered
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales (NSW) and southern Queensland	Critically endangered
Poplar box grassy woodland on alluvial plains	Endangered
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered
Flora Species - 4	
Dicanthium setosum (Bluegrass)	Vulnerable
Homopholis belsonii (Belson's panic)	Vulnerable
Swainsona murrayana (Slender Darling Pea)	Vulnerable
Tylophora linearis	Endangered
Threatened Fauna Species – 14	
Australasian bittern (*Botaurus poiciloptilus*)	Endangered
Australian painted snipe (*Rostratula australis*)	Endangered
Border thick-tailed gecko (*Uvidocolus sphyrurus*)	Vulnerable
Corben's long-eared bat (*Nyctophilus corbeni*)	Vulnerable
Curlew sandpiper (*Calidris ferruginea*)	Critically endangered, Migratory
Dunmall's snake (*Furina dunmalli*)	Vulnerable
Five-clawed worm-skink (*Anomalopus mackayi*)	Vulnerable
Grey-headed flying-fox (*Pteropus poliocephalus*)	Vulnerable
Koala (*Phascolarctos cinereus*)	Vulnerable
Large-eared pied bat (*Chalinolobus dwyeri*)	Vulnerable
Painted honeyeater (*Grantiella picta*)	Vulnerable
Red goshawk (*Erythrotriorchis radiatus*)	Vulnerable
Spot-tailed quoll (*Dasyurus maculatus*)	Endangered
Swift parrot (*Lathamus discolor*)	Critically endangered

Table note:

* Although these species have been subject to this assessment White-throated Needletail is a purely aerial forager in Australia (including over heavily disturbed habitats) and will not be subject to impacts from the Project.

2.2 Habitat suitability

'Habitat suitability' is the first key factor used in the assessment process to determine the nature of the proposals impact on MNES species. Habitat suitability is based on the habitat type present for the target species.

Habitat for MNES species was divided into four distinct categories based on habitat modelling, available scientific information, and expert advice contained within the biodiversity planning assessments (BPA) (DES 2018). The habitat categories include:

- Core habitat
- Essential habitat
- General habitat
- Unlikely habitat.

Table 2.4 defines each habitat category. A specific set of habitat assumptions for each MNES species subject to this assessment has been developed to categorise species habitat into categories defined in Table 2.4.

For the purposes of the assessment, each habitat category was assigned a ranking to reflect the ecological value of each habitat category to the target species (refer Table 2.4).

Core and essential habitat have been assigned a higher rating than general habitat to capture the greater risk to a species when areas of known habitat or habitat which supports key resources necessary for maintaining a population (i.e. potential breeding, roosting or foraging habitat) is affected by the proposal. The greater weighting ensures that habitat suitability is captured and reflected in the adverse impact assessment.

A 'fatal flaw' trigger was allocated to the habitat category core habitat to reflect the high ecological value of core habitat to the target species.

Areas of important habitat are captured in this adverse impact assessment as core habitat. Core habitat represents an area of habitat in which the target species is known, and the area of habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Core habitat also captures populations that are limited geographically within the region. As areas of core habitat represent important habitat for the target species, core habitat is allocated a fatal flaw to reflect the high ecological value of the habitat area.

Table 2.4 Habitat category and ranking

Habitat category	Description[1]	Habitat suitability[#]
Unlikely habitat	Unlikely habitat areas are those areas that do not contain records of the particular species and contain no habitat values to support the presence or existence of resident or migratory individuals or populations of the species.	N/A = 0
General habitat	General habitat consists of areas or locations that are used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as essential/core habitat. General habitat also includes areas defined from known records or habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records. General habitat may include areas of suboptimal habitat for species. As potential habitat for many species known or predicted to occur within the subject land include most of the vegetation communities of the New England North West region of NSW, the general habitat category restricts the habitat to a more limited and realistic set of environmental parameters that are supported by literature and field-based observation.	Low = 1
Essential habitat	Essential habitat is an area containing resources that are considered essential for the maintenance of populations of the species (e.g. potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). Essential habitat is defined from known records and/or expert advice (including the findings of pre-clearance surveys).	Moderate = 35

Habitat category	Description[1]	Habitat suitability[#]
Core habitat	Core habitat consists of essential habitat in which the species is known, and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Also included within this category are populations that are limited geographically within the region.	High = 120** ***Fatal flaw***

Table notes:

1 As defined in the Predictive Habitat Modelling Procedure (Appendix A of the Biodiversity Technical Report)
[#] The numerical values associated with the category ranks are described in further detail in Section 2
** Fatal flaw

2.3 Species/Threatened ecological communities resilience

The second key factor incorporated in the assessment was 'species resilience'. The resilience of a species was defined and ranked to reflect the nature of the species response to disturbance.

To provide for a transparent, consistent and repeatable approach to assess species resilience, a scoring system was developed to rank species in order of their resilience using a set of defined criteria. The scoring system was informed by the 'system for assessing vulnerability of species (SAVS)' (Bagne et al. 2011) which was developed to assess the relative vulnerability, or resilience, of a species to the potential effects of climate change. SAVS is a published methodology which has been previously adopted and implemented by the United States Department of Agriculture. However, in order to account for the specific requirements of Threatened ecological communities (TECs), augmentations to the above system have been made so to increase the applicability of this system to TECs.

The species/TEC resilience assessment provides an assessment of species/TEC resilience to proposal disturbances, including secondary impacts such as edge effects and weed proliferation, which may be associated with the proposal. The resilience assessment criteria provide a means of assessing a species/TEC resilience to both primary and secondary disturbances by considering influences and impacts such as a species response to habitat disturbance, resource fluctuations, increase risk from predation, reduced food/prey availability, etc.

A species resilience questionnaire (refer Table 2.5) or a TEC questionnaire (refer Table 2.6) is completed for each MNES species/TEC subject to the assessment matrix. The relevant resilience questionnaire contains thirteen questions (for species) and eight questions (for TECs) which have been amended from the SAVS questionnaire to ensure they provided for an appropriate impact assessment for the nature of the proposal disturbance. Questions in the SAVS questionnaire pertaining to a species physiological and phonological (sounds or calls) response to climate change were not incorporated into the current methodology.

The species resilience scoring system contains thirteen (species) or eight (TECs) assessment criteria. Each predictive criterion corresponds to a single question which represents resilience. The results of each question feed into the scoring system which provides for a measure of species/TEC resilience.

The degree of vulnerability of the target species/TEC is captured in the assessments of species/TEC resilience to reflect the differing sensitivities that Endangered, Vulnerable or Migratory species have to disturbance. Criterion 1, threatening processes, provides for an assessment of potential impact on recognised threatening processes for the target species or TEC which have resulted in the species threatened status and subsequent decline.

If there is insufficient information to address any species resilience assessment criterion, the highest score attributable to that criterion is allocated to reflect uncertainties in the data and to provide for a conservative approach to the assessment of species resilience.

The score produced by the questionnaire is then applied to Table 2.7 to provide a ranking for resilience which is reflected in the assessment matrix.

A fatal flaw trigger was allocated to 'low' ranked species/TEC resilience to reflect the reduced ability of the species/TEC to tolerate, adapt or recover from disturbance.

The results of the resilience questionnaire for each species are provided in Appendix B.

Table 2.5 **Species resilience questionnaire for threatened and migratory species**

Item	Question	Species response (score)
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes **(2)** ▪ Unlikely to change as a result of the projected changes **(0)**
Q2.	Area and distribution – breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ▪ Decline or shift from current location **(2)** ▪ Stay the same and in approximately the same location **(0)**
Q3.	Area and distribution – non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ▪ Decline or shift from current location **(2)** ▪ Stay the same and in approximately the same location **(0)**
Q4.	Habitat components – breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ▪ Expected to decrease or habitat components required for breeding unknown **(2)** ▪ Unlikely to change **(0)**
Q5.	Habitat components – non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ▪ Expected to decrease or habitat components required for non-breeding unknown **(2)** ▪ Unlikely to change **(0)**
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	▪ Low ability to disperse **(2)** ▪ Mobile, but dispersal is sex-biased (only one sex disperses) **(1)** ▪ Very mobile, both sexes disperse **(0)**
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	▪ Additional habitats required that are separated from breeding and non-breeding habitats (e.g. most migratory species) **(2)** ▪ No additional habitats required that are separated from breeding and non-breeding habitats (e.g. most resident species and short-distance migrants) **(0)**
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(2)** ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)**
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ▪ Once per year or less **(2)** ▪ More than once per year **(0)**
Q10.	Food resources: Are important food resources for this species expected to change?	▪ Primary food source(s) are expected to be negatively impacted by projected changes **(2)** ▪ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes **(0)**
Q11.	Predation: Is the species predation vulnerability expected to change?	▪ Species predation vulnerability: ▪ Is expected to increase as a result of the projected changes **(2)** ▪ Is not expected to be impacted by the projected changes **(0)**

Item	Question	Species response (score)
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	▪ Disease prevalence is expected increase with projected changes **(2)** ▪ No known effects of expected changes on disease prevalence (0)
Q13.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes **(2)** ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)**

Table 2.6 TEC resilience questionnaire for threatened ecological communities

Item	Question	TECs response (score)
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target community expected to change as a result of the projected changes?	Community's threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes **(2)** ▪ Unlikely to change as a result of the projected changes **(0)**
Q2.	Area and distribution: Are areas or locations of the associated vegetation type associated with this community expected to change?	Area used for non-breeding habitat expected to: ▪ Decline or shift from current location **(4)** ▪ Stay the same and in approximately the same location **(0)**
Q3.	Habitat components: Are other specific habitat components required by this community expected to change?	Required habitat components: ▪ Expected to decrease or habitat components required for non-breeding unknown **(4)** ▪ Unlikely to change **(0)**
Q4.	Survival during resource fluctuation: Does this community have alternative strategies/ pathways to cope with variable resources or climate conditions?	Community has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(3)** ▪ Flexible strategies to cope with variable resources across multiple years (eg alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)**
Q5.	Resources: Are important resources for this community expected to change?	▪ Primary resources are expected to be negatively impacted by projected changes **(4)** ▪ Primary resources are not expected to be impacted by projected changes **(0)**
Q6.	Susceptibility to negative impacts: Is the community's susceptibility to negative impacts expected to change?	▪ Susceptibility to impacts: – Is expected to increase as a result of the projected changes **(4)** – Is not expected to be impacted by the projected changes **(0)**
Q7.	Disease: Is prevalence of diseases known to cause widespread mortality in this community expected to change?	▪ Disease prevalence is expected increase with projected changes **(3)** ▪ No known effects of expected changes on disease prevalence (0)
Q8.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes **(3)** ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)**

Table 2.7 Species resilience and ranking

Questionnaire score^	Species resilience#
0 – 1	High = 1
2 – 15	Moderate = 35
≥ 16	Low = 120** *Fatal flaw*

Table notes:

^ The value ranges provided for 'questionnaire score' have been selected following review of species information and completion of species questionaries' (refer Appendix B) as they are considered to provide for a suitable ranking which appropriately reflects the resilience of the species

The numerical values associated with the category ranks are described in further detail in Section 2.3

** Fatal flaw

2.4 Habitat resilience

The third key factor incorporated in the assessment was 'habitat resilience'. The resilience of species habitat was defined and ranked to reflect the species' habitat capacity to respond to disturbance.

The habitat resilience input provides for an assessment of the literature supported anticipated time required for an area of species habitat to naturally regenerate to a point where the appropriate microhabitat features to support the target species are re-established. The AIAM is subject to the MNES fauna species listed in Section 2.1 and their habitat.

To define habitat resilience, the natural regeneration time of the key vegetation communities occurring within the subject land were noted. The results are summarised in Table 2.8.

It is important to note that the natural regeneration times indicated in Table 2.8are provided as a guide only with natural regeneration times to vary between sites dependent upon surrounding factors such as landscape context, soil conditions and rainfall patterns.

To capture a species multiple habitat requirement, habitats which are used by each target species are mapped and provided for within the AIAM via the habitat suitability input. Using GIS, each area of species habitat which intersects with the disturbance area (i.e. the proposal) is assessed using the assessment methodology. As such, the variety of habitats which may be used by the target species within the disturbance area are captured in the assessment.

The areas of habitat which are determined to be adversely impacted by the proposal are identified and mapped. Development of a ranking system for habitat resilience for each of the habitats present within subject land was determined based on estimated recovery times following disturbance. For the purposes of ranking habitat resilience and to provide for a conservative approach, the longest natural regeneration time was used for ranking. Identified habitat types, estimate recovery times and habitat resilience ratings are provided in Table 2.9.

Table 2.8 Natural regeneration times for key Plant Community Types (PCTs) within the subject land

PCT ID	PCT Name	Natural regeneration time	Habitat resilience rating (refer Table 2.9)
1	Candidate grasslands	2 to 12 months Non-woody species capable of natural regeneration post disturbance Species sexual maturity reached within 2 months and generation times as short as 6 months	High (1)
27	Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	50 years + Mature stands of *Acacia pendulosa* are likely to take greater that 50 years to develop into an open woodland	Low (120)

PCT ID	PCT Name	Natural regeneration time	Habitat resilience rating (refer Table 2.9)
35	Brigalow - Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion	100 years + Mature stands of Brigalow may take upwards of 100 years to develop	Low (120)
52	Queensland Bluegrass +/- Mitchell Grass grassland on cracking clay floodplains and alluvial plains mainly the northern-eastern Darling Riverine Plains Bioregion	2 to 12 months Non-woody species capable of natural regeneration post disturbance Species sexual maturity reached within 2 months and generation times as short as 6 months	High (1)
53	Shallow freshwater wetland sedgeland in depressions on floodplains on inland alluivial plains and floodplains	2 to 12 months Non-woody species capable of natural regeneration post disturbance	High (1)
55	Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions.	100 years + Mature stands of Belah may take upwards of 100 years to develop	High (1)
56	Poplar Box - Belah woodland on clay-loam soils on alluvial plains of north-central NSW	100 years + Mature stands of Poplar box - Belah may take upwards of 100 years to develop	High (1)
98	Poplar Box - White Cypress Pine - Wilga - Ironwood shrubby woodland on red sandy-loam soils in the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	100 years + Mature stands of Poplar Box - White Cypress Pine - Wilga - Ironwood shrubby woodland may take upwards of 100 years to develop	High (1)
147	Mock Olive - Wilga - Peach Bush - Carissa semi-evergreen vine thicket (dry rainforest) mainly on basalt soils in the Brigalow Belt South Bioregion	100 years + Mature stands of Mock Olive - Wilga - Peach Bush - Carissa semi-evergreen vine thicket may take upwards of 100 years to develop	High (1)
192	Silver-leaved Ironbark - Poplar Box +/- Ironwood shrub - grass woodland on rises in the north-western plains of NSW	100 years + Mature stands of Silver-leaved Ironbark - Poplar Box +/- Ironwood shrub - grass woodland may take upwards of 100 years to develop	High (1)
244	Poplar Box grassy woodland on alluvial clay-loam soils mainly in the temperate (hot summer) climate zone of central NSW (wheatbelt).	100 years + Mature stands of Poplar Box grassy woodland may take upwards of 100 years to develop	High (1)
247	Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion	6-20 years Non-woody species capable of natural regeneration post disturbance. Regenerate rapidly following flooding however if root-stock is removed (i.e. during clearing) regeneration is slow (Wiltshire and Schmidt 1988)	Moderate (35)
418	White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, Brigalow Belt South Bioregion	100 years + Mature stands of White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland may take upwards of 100 years to develop	High (1)
628	Carbeen +/- Coolabah grassy woodland on floodplain clay loam soil on north-western NSW floodplains, mainly Darling Riverine Plain Bioregion	100 years + Mature stands of Carbeen +/- Coolabah grassy woodland may take upwards of 100 years to develop	High (1)

PCT ID	PCT Name	Natural regeneration time	Habitat resilience rating (refer Table 2.9)
NNV	Non-native vegetation	2 to 12 months Non-woody species capable of natural regeneration post disturbance Species sexual maturity reached within 2 months and generation times as short as 6 months	High (1)

Table note:

1 The vegetation communities selected for inclusion in Table 2.8 are those outlined in the Appendix B: Biodiversity Technical Report document number: 2-0001-270-EAP-10-RP-0401

Table 2.9 Habitat resilience and ranking

Natural regeneration period^	Habitat resilience#
0 to 5 years	High = 1
6 to 30 years	Moderate = 35
31 years and greater	Low = 120** *Fatal flaw*

Table notes:

^ The natural regeneration period associated with each category rank has been defined by the natural regeneration times (refer Table 2.6) comparatively associated with communities (i.e. grasslands which are known to regenerate quickly, remnant communities which are the most complex in regard to structure and composition and thus have longer regeneration times and regrowth communities which act as the midpoint between non-remnant/grassland and remnant communities)

The numerical values associated with the category ranks are described in further detail in Section 2.0

** Fatal flaw

A habitat resilience layer was created for use in GIS to facilitate the assessment process. The natural regeneration times noted in Table 2.8 for the key vegetation communities present within the study area were used to inform the series of assumptions which were used to create the habitat resilience GIS layer. The habitat resilience GIS layer was defined by three categories, including resilient habitat, moderately resilient habitat and non-resilient habitat. Habitat resilience was categorised by the natural regeneration time for the habitat type (refer Table 2.9), with respect to the following assumptions:

- **Resilient habitat** – Resilient habitat consists of non-remnant vegetation in addition to grassland dominated PCTs
- In a number of bioregions in NSW, some grassland dominant PCTs are analogous to native grassland TECs. These however, have also been included in the development of the habitat resilience GIS layer as they are characterised by non-woody species which are capable of quick regeneration post disturbance.
- **Moderately resilient habitat** – The moderately resilient habitat layer consists of all areas currently mapped as regrowth vegetation by the NSW Office of Environment and Heritage (OEH).
- **Non-resilient habitat** – The non-resilient habitat layer consists of remnant vegetation and all areas mapped as PCTs with the exclusion of those included in the resilient habitat layer.

A 'fatal flaw' trigger was allocated to low ranked habitat resilience to reflect the reduced ability of the habitat to recover from disturbance.

The habitat resilience layer is illustrated in Figure 2.1.

2.5 Landscape attributes

The fourth key factor incorporated in the adverse impact assessment methodology is 'landscape attributes'. The incorporation of landscape attributes allows for an assessment of impact on habitat function and provides a reference for impact assessment on available habitat within proximity to the disturbance area.

To provide for landscape context in the impact assessment process, the assessment of landscape-scale attributes from the *Biodiversity Assessment Methodology* (BAM) (OEH 2017) was adapted and included in the assessment.

The potential impact of the proposed disturbance on regionally availably habitat for each species was assessed using three key landscape attributes, including size of habitat patch, habitat connectivity and habitat context.

For the purposes of the landscape attribute assessment, the species habitat suitability layer was used. The species habitat suitability layer was developed using a combination of pre-clearance ground-truthed habitat data (which was collected for the disturbance footprint) and predictive habitat modelling (for areas within a 1 km radius of the disturbance area).

The habitat categories delineated in the habitat suitability layer were merged (i.e. core, essential and general) in recognition of the contribution all degrees of habitat have in increasing or maintaining biodiversity values, especially in highly modified landscapes (Bowen et al. 2007). A landscape attribute assessment was conducted for each species subject to the adverse impact assessment (that is those species detailed in Table 2.3).

Each landscape attribute is discussed in further detail below.

Imagery: NSW Imagery Service (tile Goondiwindi 13-Aug-2011) © Department of Finance, Services & Innovation 2018

Map by: ADIMF Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-201907181350_GIS_ecology_mapping\NS2B_Appendix_B_Hres_FFJV_A4P100pc.mxd Date: 19/02/2020 10:30

Legend

- Localities
- NSW/QLD border
- Subject land
- Study area

Habitat Resilience

- High
- Moderate
- Low

A4 scale: 1:190,000

0 0.75 1.5 3 4.5 6 7.5 Km

Future Freight
Integrating Community, Environment and Engineering

Date: 17/02/2020 Version: 1

Coordinate system: MGA56

North Star to QLD/NSW Border

Figure 2.1:
Habitat resilience within the study area

2.5.1 Size of habitat patch

The size of habitat patch factor is a measure of the size of the patch of species habitat in which the disturbance area is located. The scoring reflects the importance of smaller patches of habitat in which the disturbance area is located. Larger patches of habitat are considered less susceptible to ecological edge effects and are also less susceptible to propagule pressure from exotic pasture species such as Buffel grass (Eyre et al. 2009; Lindenmayer et al. 1999; McIntyre et al. 2000).

For the purposes of assessment, the habitat suitability layer was used to calculate size of habitat patch. The size of the habitat patch within which the disturbance area intersects was calculated and ranked with the ranking system outlined in Table 2.10.

Table 2.10 Size of habitat patch – Categorisation and ranking scores

Description	Category	Score
0 ha. The assessment area does not occur within a habitat patch.	Negligible	0*
Patch size is ≥ 200 ha	Very low	2
Patch size is ≥ 100 ha to 200 ha	Low	5
Patch size is ≥ 25 ha to 100 ha	Moderate	7
Patch size is ≥ 5 ha to 25 ha	High	10
Patch size is > 0 ha to 5 ha	Very high	12

Table note:

* Note that for species which were assessed to have a high species resilience (which captures factors such as high species mobility) the size of the habitat patch was considered to be negligible and allocated a score of 0. The species assessed as having a high resilience were not considered to be reliant on large patches of contiguous habitat, with the species considered to be highly mobile, not reliant on specific micro-habitat features and able to persist in mosaic vegetation.

2.5.2 Connectivity

Connectivity relates to the capacity species have to disperse through the landscape between suitable patches of habitat, and therefore has important implications for species persistence (With 2004).

As a landscape level attribute, connectivity aims to assess the degree to which the disturbance area is connected with areas of habitat for the species.

Using the species habitat suitability layer, the percentage of the disturbance areas perimeter which intersects with an area of species habitat was measured and ranked to assess potential impact on species connectivity. The ranking scores used to categorise connectivity are presented in Table 2.11.

Table 2.11 Connectivity – categorisation and ranking scores

Description	Category	Score
0%. The assessment unit is not connected to a habitat patch.	Negligible	0
> 0% to < 50% of the assessment unit's perimeter is connected to a habitat patch	Low	2
50% to 75% of the assessment unit perimeter is connected to a habitat patch	Moderate	4
> 75% of the assessment unit perimeter is connected to a habitat patch	High	5

2.5.3 Context

The context attribute refers to the amount of species habitat that is retained in the landscape proximal to the disturbance area. A 1 km radius buffer from the perimeter of the disturbance area was used to delineate a circular spatial extent. The scoring and ranking presented in Table 2.12 relates to the proportion of species habitat which is retained within the 1 km buffer landscape.

The ranking scores used to categorise context have been derived from the literature, which generally demonstrate that there is a 10 % to 30% threshold of habitat loss within a landscape below which species will be lost from the ecosystem (Andren 1994; McIntyre et al. 2000; Radford et al. 2005).

Table 2.12 Context – categorisation and ranking scores

Description	Category	Score
0%. There is no habitat within a 1 km buffer of the assessment unit	Negligible	0
> 75% of the assessment unit's 1 km buffer area contains habitat	Low	2
≥ 30% to 75% of the assessment unit's 1 km buffer area contains habitat	Moderate	4
< 30% of the assessment unit's 1 km buffer area contains habitat	High	5

2.5.4 Landscape attribute score

The scores which were produced following the landscape attribute assessment (i.e. size of patch, connectivity and context) were added and then applied to Table 2.13 to obtain a final score and provide a ranking for landscape attributes which is reflected in the assessment matrix.

Table 2.13 Landscape attribute ranking – Categorisation and ranking scores

Combined score	Category	Score
0 to 8	Low	1
9 to 14	Moderate	35
15 to 22	High	120

2.6 Disturbance nature

The final key factor by which the AIAM determines the nature of the proposal's impact on MNES species is disturbance nature. Disturbance nature is included in the AIAM to provide reference to the type of disturbances associated with the Project and their anticipated impact on individual MNES species and their preferred habitat.

2.7 Final impact

The assessment matrix presents a final impact score which states whether the proposal's impact on the target species is considered to be adverse or not adverse. The assessment matrix and associated reporting presents the assessment process by which the final impact score, including the categorisation of the key factors, is derived to ensure transparency, consistency and repeatability in the assessment process.

To arrive at the final impact score, the key factor inputs; including habitat suitability, species resilience, habitat resilience and landscape attributes are summed and ranked (as defined in Sections 2.2 to 2.5).

The scoring of the key factors includes the provision of a fatal flaw trigger which identifies extreme risk factors that result in a significant residual adverse impact on the target species and/or their preferred habitat. The fatal flaw trigger captures scenarios were the level of risk to the species is too high, automatically resulting in an adverse impact output, regardless of the final summed score of all key factors.

The scoring system developed to derive the final impact score is presented in Table 2.14.

The values presented in Table 2.14 were derived by examining the various value combinations which may be derived from the assessment matrix and categorising the values in a manner which reflects the nature, adverse or not adverse, of the impact.

Table 2.14 Final score ranking system

Score (sum of habitat suitability, species resilience and habitat resilience)	Final impact	Description
3 to 72	No adverse impact	Significant residual adverse impact to target species is anticipated to be not significant in nature, with the species and habitat considered resilient to the nature of the proposed disturbance and able to recover un-aided to the pre-works disturbance state
106 to 480 A fatal flaw is triggered (total score is not applicable in this event)	Adverse impact	Significant residual adverse impact to target species is anticipated to be significant in nature, with the species and habitat not considered to be resilient to the nature of the proposed disturbance or able to recover un-aided to the pre-works disturbance state

The simplest scenario at which a not adverse impact may occur would be if each attribute is allocated the minimum score for its category, resulting in a score of 3.

A score of 106 is defined as the minimum score for an adverse impact. To account for cumulative impacts and provide for a conservative measure of impact with respect to the precautionary principle which governs the EPBC Act, if three of the four key factors are attributed a moderate score, and the remaining attribute was allocated a low score (which would total 106), an adverse impact would still be triggered.

Two moderate impact values when combined with two low values (72) is not considered to constitute an adverse impact with respect to the resilience represented in the balance of the remaining attributes which were allocated a low score.

As discussed in further detail in Section 2, the combination of three moderate impact values when combined with one low value was considered the trigger for an adverse impact following an extensive review process which involved running a number of assessment scenarios for different species through the AIAM to determine if the affected values would affect the species survival. The assessment scenarios were assessed by suitably qualified ecologists and included extensive reviews of scientific literature documenting the species ecological requirements.

The fatal flaw trigger was built into the AIAM to capture factors which would have a significant residual adverse impact on a species, regardless of the degree of impacts to the other key factors subject to the AIAM.

An adverse impact may occur via the trigger of a fatal flaw, with a fatal flaw allocated a score of 120, a score higher than the minimum score attributable to an adverse impact. Consequently, the maximum adverse impact score would occur in the event of four fatal flaws, with the resultant score totalling 480. Conversely, the highest score for an impact which is not adverse was defined at 72, which allows for no more than two moderate scored key factors.

The assessment matrix is derived and calculated in the Model Builder function of the GIS program ArcMap. For demonstrational purposes, Table 2.15 presents a worked example of the assessment matrix for two species scenarios. Appendix A provides an outline of the GIS model which was used to derive the final impact score.

The GIS model was designed to produce results in accordance with the assessment matrix which presents a final impact which states whether the proposal's impact on the target species is considered to be adverse or not adverse. The values of 1, 35, and 120 were used in the GIS model to represent the low, moderate, and high values from the assessment matrix. These particular numeric values were chosen so that the operational functions of the assessment matrix can be performed within the GIS model.

There are four parameters in the assessment matrix for any given area (i.e. habitat suitability, species resilience, habitat resilience and landscape attributes). Each of these parameters can have a value of low (1), moderate (35) or high (120). These values are combined to produce a total score. In accordance with the assessment matrix, one high value represents a fatal flaw and will result in a score of at least 120. Three moderate values and one low value also represent a fatal flaw and result in a score of 106 (3 x moderate [score 35] + 1 x low [score 1]). Once the four parameters are combined, each area that has a score of 106 or greater is classified as an adverse impact and areas with lower scores are classified as no adverse impact. This method and the values used enable the GIS model to produce results in accordance with the assessment matrix.

Numerical thresholds for final impact were derived by examining various value combinations which may be derived from the assessment matrix and categorising the values in a manner which reflects the nature, adverse or not adverse, of the impact. As such, the final ranking scores (refer Table 2.14) were selected based on theories of predicted outcomes from the interactions of each input. The numerical value attributed to each category (i.e. low, moderate and high) was an arbitrary selection to facilitate GIS modelling of the AIAM model outputs. The scores assigned to each input category were not designed to artificially inflate or supress outputs, rather, they were assigned to best represent each category value.

The model is checked by inputting known (or set) scenarios and ensuing that the outputs are consistent with the known outcomes.

The results of the assessment matrix are not over-ridden or altered and provide for a conservative, unaltered assessment which is informed by the SAVS assessment methodology and peer-reviewed scientific literature.

Following the adverse impact assessment, the results are reviewed to ensure that the areas of adversely impacted habitat are appropriate for the target species and capture the degree of proposal impacts on the areas of species habitat. During review, particular attention is given to MNES fauna species (particularly focussing on migratory species) to ensure that their mobility was captured.

Table 2.15 Modelled assessment matrix extract for demonstrational purposes

Species name Common (Scientific)	**Species status** EPBC Act	**Habitat suitability**		**Species resilience** [Section 2.3 and Appendix B]	**Habitat resilience** Time until return to pre-disturbance state [Section 2.4]	**Landscape attribute** [Section 2.5]	**Disturbance type/nature** [Section 2.6]	**Final Score** [Section 2.7]	**Impact assessment** [Section 2.7]
		Habitat category As occurs within the project area (defined by predictive habitat mapping within the Project area	**Habitat suitability ranking** [Section 2.2]						
A saltbush (*Atriplex infrequens*)	Vulnerable	General	High – 120**	Low – 120**	Low – 120**	High – 120**	Permanent	**480**	**Adverse (fatal flaw)**
Curlew sandpiper (*Calidris ferruginea*)	Critically endangered	General	Low – 1	High - 1	High - 1	Low - 1	Access track / Temporary	**4**	**No adverse impact (3 to 72)**

Table notes:

GIS input

** Fatal flaw

2.8 Limitations and assumptions

The assessment process and associated outputs of the AIAM are subject to a number of limitations and assumptions including, but not limited to the following:

- The quality and quantity of information varies for individual species
- The ranking system relies on expert ecological opinion (as in ecological field survey situations) and is subject to a number of assumptions and constraints
- Periods provided for the natural regeneration of vegetation communities are general estimates only and do not account for seed availability, climatic influences and natural variability between sites
- The species resilience questionnaire discussed in Section 2.3 was informed by the SAVS which was developed to assess species resilience in response to climate change. However, the SAVS provide for a relevant assessment of species resilience to proposed disturbances. The questions in the SAVS questionnaire which pertained to a species physiological response to climate change were not used in the species resilience questionnaire.
- The species resilience questionnaires do not account for seasonal and temporal species responses. To provide for a conservative approach to species resilience assessments, a static landscape which generates the greatest species response is assumed.
- The accuracy of the habitat disturbance calculations are limited to accuracy of the GIS input files.

3 Matters of national environmental significance habitat disturbance areas

Following assessments of species and habitat resilience, and the subsequent assessment process which has been outlined in the aforementioned sections of this document, the area of habitat proposed for disturbance for each MNES species which represents the significant residual adverse impact to the species and/or its habitat values is outlined in Table 3.1.

The calculations are accurate for habitat attributes within the subject land only and does not account for the required habitat attributes outside of the subject land or the size and resilience of the species population outside of the subject land. Due to the species range and population size, excluding those which are also Critically endangered, Endangered, Vulnerable or Migratory species, the proposal is not considered to have a significant residual adverse impact on any of the migratory listed species populations.

Appendix C illustrates the areas of species habitat present within the subject land for each MNES species. The figures also illustrate the areas of species habitat subject to an adverse impact and no adverse impact from the Project.

Species habitat associations have been determined via review of field investigation results, peer-reviewed literature and expert knowledge, as discussed in further detail in the Biodiversity Technical Report.

Table 3.1 Matters of national environmental significance terrestrial species habitat disturbance areas

Species name	Non-significantly impacted habitat disturbance area[2] (ha)	Significant residual adversely impacted habitat disturbance area[2] (ha) (supported by this document, specifically the assessment detailed in Section 2 and the additional research presented in Appendix B)
Ecological communities - 4		
Brigalow (*Acacia harpophylla* dominant and co-dominant)	0	75.21
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales (NSW) and southern Queensland	0	41.98
Poplar box grassy woodland on alluvial plains	0	119.48
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	0	4.60
Weeping Myall woodlands	0	0.03
Critically endangered species - 2		
Curlew sandpiper (*Calidris ferruginea*)	54.95	37.01
Swift parrot (*Lathamus discolor*)	0	63.64
Endangered species – 4		
Australasian bittern (*Botaurus poiciloptilus*)	106.84	111.41
Australian painted snipe (*Rostratula australis*)	104.20	88.68
Spot-tailed quoll (*Dasyurus maculatus maculatus*)(Southeastern mainland population)	0	1.15
Tylophora linearis	0	44.23
Vulnerable species – 13		
Border thick-tailed gecko (*Uvidicolus sphyrurus*)	0	67.18
Corben's long-eared bat (*Nyctophilus corbeni*)	2.38	280.36
Dichanthium setosum (Bluegrass)	45.12	237.10
Dunmall's snake (*Furina dunmalli*)	0	75.39
Five-clawed worm-skink (*Anomalopus mackayi*)	41.98	219.47
Grey-headed flying-fox (*Pteropus poliocephalus*)	6.5	271.37
Homopholis belsonii (Belson's panic)	42.63	203.51

Species name	Non-significantly impacted habitat disturbance area[2] (ha)	Significant residual adversely impacted habitat disturbance area[2] (ha) (supported by this document, specifically the assessment detailed in Section 2 and the additional research presented in Appendix B)
Koala (*Phascolarctos cinereus*)	25.74	297.39
Large-eared pied bat (*Chalinolobus dwyeri*)	0	71.79
Painted honeyeater (*Grantiella picta*)	15.75	295.18
Red goshawk (*Erythrotriorvhis radiatus*)	0	4.03
Swainsona murrayana (Slender Darling pea)	41.98	211.77
White-throated needletail (*Hirundapus caudacutus*)*	247.54	453.32

Table 3.2 Matters of national environmental significance terrestrial species habitat provided by habitat type units

Species name	Total impacted habitat disturbance area (ha)	PCT														Riparian zones	Waterbodies and ephemeral swamps	Watercourses	Aerial
		27	*35*	*36*	*52*	*53*	55	56	98	147	192	244	247	418	628				
Threatened ecological communities - 4																			
Brigalow (*Acacia harpophylla* dominant and co-dominant)	75.21		✓																
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales (NSW) and southern Queensland	41.98				✓														
Poplar box grassy woodland on alluvial plains	119.48							✓				✓							
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	4.60									✓									
Weeping myall woodlands	0.03	✓																	
Critically endangered species - 2																			
Curlew sandpiper (*Calidris ferruginea*)	91.96					✓											✓		
Swift parrot (*Lathamus discolor*)	63.64			✓										✓	✓				
Endangered species - 4																			
Australasian bittern (*Botaurus poiciloptilus*)	218.25			✓		✓							✓			✓	✓	✓	
Australian painted snipe (*Rostratula australis*)	192.89			✓	✓	✓							✓			✓	✓	✓	
Spot-tailed quoll (*Dasyurus maculatus maculatus*) (Southeastern mainland population)	1.51			✓						✓							✓		
Tylophora linearis	44.23														✓				

Species name	Total impacted habitat disturbance area (ha)	PCT														Riparian zones	Waterbodies and ephemeral swamps	Watercourses	Aerial
		27	*35*	*36*	*52*	*53*	55	56	98	147	192	244	247	418	628				
Vulnerable species - 13																			
Border thick-tailed gecko (*Uvidicolus sphyrurus*)	67.18										✓			✓					
Corben's long-eared bat (*Nyctophilus corbeni*)	282.74	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓					
Dichanthium setosum (Bluegrass)	282.22	✓	✓		✓		✓	✓						✓					
Dunmall's snake (*Furina dunmalli*)	75.39		✓																
Five-clawed worm-skink (*Anomalopus mackayi*)	261.45	✓	✓	✓	✓		✓	✓				✓	✓		✓				
Grey-headed flying-fox (*Pteropus poliocephalus*)	277.87		✓	✓			✓	✓		✓		✓		✓	✓				
Homopholis belsonii (Belson's panic)	246.13	✓	✓		✓		✓	✓	✓	✓		✓							
Koala (*Phascolarctos cinereus*)	323.13		✓	✓			✓	✓	✓		✓	✓		✓	✓				
Large-eared pied bat (*Chalinolobus dwyeri*)	71.79									✓	✓			✓					
Painted honeyeater (*Grantiella picta*)	310.93	✓	✓	✓			✓	✓	✓	✓	✓	✓		✓	✓				
Red goshawk (*Erythrotriorvhis radiatus*)	4.03			✓												✓			
Swainsona murrayana (Slender Darling pea)	253.75	✓	✓		✓		✓	✓				✓	✓		✓				
White-throated needletail* (*Hirundapus caudacutus*)	700.86																		✓

Table notes:

✓ Refer to Appendix B for further detail regarding species specific microhabitat requirements

* Although subject to this assessment White-throated Needletail are purely aerial foragers in Australia (including over heavily disturbed habitats) and will not be subject to impacts from the Project. As such they are not assessed further as 'significantly impacted' by the Project.

4 References

Andren, H. (1994). ‘Effects of habitat fragmentation on birds and mammals in landscapes with different proportions of suitable habitat: a review’, *Oikos*, vol. 71, pp. 355–366.

Bagne, K; Friggens, M and Finch, D (2011). *A System for Assessing Vulnerability of Species (SAVS) to Climate Change*, General Technical Report RMRS-GTR-257, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: Fort Collins.

Bowen, M; McAlpine, C; House, A and Smith, G (2007) ‘Regrowth forests on abandoned agricultural land: a review of their habitat values for recovering forest fauna’, *Biological Conservation*, vol 140, pp 273–296.

Department of Environment and Energy (2013) *Matters of National Environmental Significance – Significant Impact Guidelines* Version 1.1.

Department of Environment and Science (2018) *Biodiversity planning assessments*. Available from: https://www.qld.gov.au/environment/plants-animals/biodiversity/planning.

Department of Sustainability, Environment, Water, Population and Communities (2012) *EPBC Act Environmental Offsets Policy*.

Eyre, T., Maron, M., Mathieson, M., Haseler, M. (2009) Impacts of grazing, selective logging and hyper-aggressors on diurnal bird fauna in intact forest landscapes of the Brigalow Belt, Queensland

Lindenmayer, D., Cunningham, R., Pope, M., Donnelly, C. (1999) ‘The response of arboreal marsupials to landscape context: A large-scale fragmentation study’, *Journal of Biogeography*, vol 9, pp 594-611

McIntyre, S., McIvor, J.G., MacLeod, N.D. (2000) Principles for sustainable grazing in eucalypt woodlands: landscape-scale indicators and the search for thresholds. In: Hale, P., Petrie, A., Moloney, D., Sattler, P. (Eds.), *Management for Sustainable Ecosystems*, The University of Queensland, Brisbane, pp. 92–100.

Office of Environment and Heritage (2017) The Biodiversity Assessment Method, NSW Government

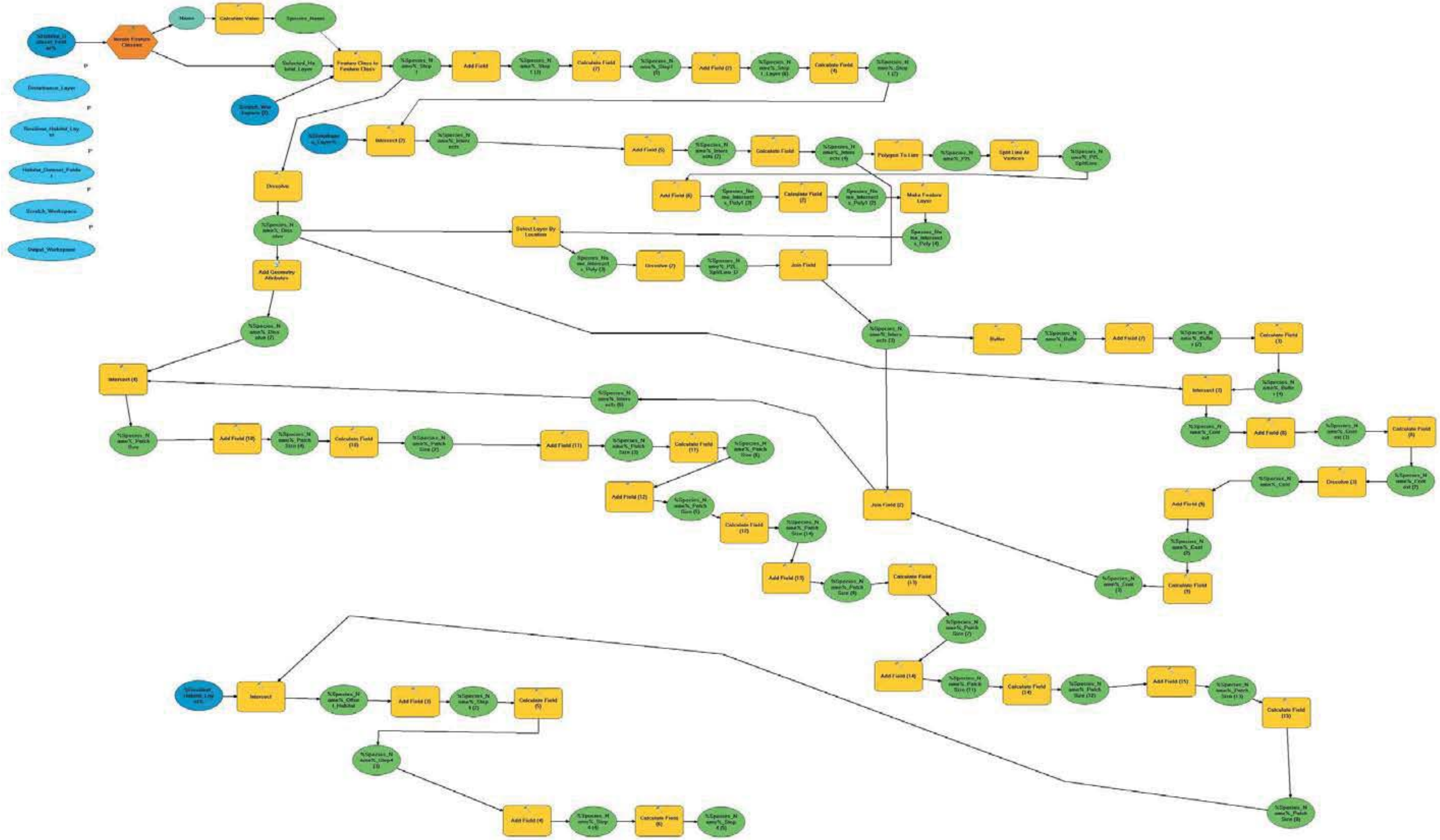
Radford, J.Q., Bennett, A.F. & Cheers, G.J. (2005), ‘Landscape level thresholds of habitat cover for woodland-dependent birds’, *Biological Conservation*, 124, 317–337

Wiltshire, D., Schmidt, M. (1988) Field guide to the common plants of the Cooper basin (South Australia and Queensland), Santos Ltd, Adelaide

With, K. (2004) ‘Assessing the risk of invasive spread in fragmented landscapes’, *Risk Analysis*, vol 24, pp 803-815

Appendix A

AIAM – GIS Model Script



Appendix B

Species resilience questionnaires

Contents

1 Introduction

The following section presents the species resilience questionnaires which have been completed for each MNES subject to the EPBC Act controlled action approval.

A summary of the species resilience assessments for each flora and fauna species subject to the EPBC Act controlled action approval is provided in Table 1.1

Table 1.1 Summary of species resilience assessments

Species name	EPBC Act status	Species resilience	
		Questionnaire score	Ranking
Threatened Ecological communities (TECs) - 7			
Brigalow (*Acacia harpophylla* dominant and co-dominant)	Endangered	10	Moderate
Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	Endangered	10	Moderate
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales (NSW) and southern Queensland	Critically endangered	17	Low
Poplar Box Grassy Woodland on Alluvial Plains	Endangered	10	Moderate
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	10	Moderate
Weeping Myall Woodland	Endangered	10	Moderate
White-box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically endangered	10	Moderate
Flora Species - 6			
Dichanthium setosum (Bluegrass)	Vulnerable	8	Moderate
Homopholis belsonii (Belson's panic)	Vulnerable	10	Moderate
Cadellia pentastylis (Ooline)	Vulnerable	10	Moderate
Tylophora linearis	Endangered	8	Moderate
Swainsona murrayana (Slender Darling Pea)	Vulnerable	8	Moderate
Thesium australe (Austral toadflax)	Vulnerable	8	Moderate
Fauna Species - 16			
Australasian bittern (*Botaurus poiciloptilus*)	Endangered	0	High
Australian painted snipe (*Rostratula australis*)	Endangered	2	Moderate
Dunmall's snake (*Furina dunmalli*)	Vulnerable	10	Moderate
Five-clawed worm-skink (*Anomalopus mackayi*)	Vulnerable	8	Moderate
Grey-headed flying-fox (*Pteropus poliocephalus*)	Vulnerable	0	High
Koala (*Phascolarctos cinereus*)	Vulnerable	13	Moderate
Painted honeyeater (*Grantiella picta*)	Vulnerable	8	Moderate
Red goshawk (*Erythrotriorchis radiatus*)	Vulnerable	4	Moderate
Silver perch (*Bidyanus bidyanus*)	Critically endangered	6	Moderate
Spot-tailed quoll (*Dasyurus maculatus*)	Endangered	14	Moderate
White-throated needletail (*Hirundapus caudacutus*)	Vulnerable, Migratory	0	High
Curlew sandpiper (*Calidris ferruginea*)	Critically endangered, Migratory	0	High

Species name	EPBC Act status	Species resilience	
		Questionnaire score	Ranking
Corben’s long-eared bat (*Nyctophilus corbeni*)	Vulnerable	6	Moderate
Swift parrot (*Lathamus discolor*)	Critically endangered	4	Moderate
Border thick-tailed gecko (*Uvidicolus sphryrurus*)	Vulnerable	14	Moderate
Murray cod (*Maccullochella peelii*)	Vulnerable	6	Moderate

2 Threatened ecological communities

2.1 Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales (NSW) and southern Queensland

2.1.1 Status

EPBC Act – Critically endangered

BC Act – Not listed

2.1.2 Ecology

Characteristics and defining features

The Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Queensland TEC occurs on basalt and fine-textured alluvial plains of northern NSW and southern Queensland. Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Queensland TEC change with seasonal conditions and are dominated by perennial tussock grasses such as *Astrebla* spp.(Mitchell grasses), *Austrostipa aristiglumis* (Plains grass), *Dichanthium sericeum* (Queensland blue grass), *Themeda australis* (Kangaroo grass), *Panicum queenslandicum* (Yadbila) or one of 13 other indicator grass species (refer Photograph 2.1). The composition of the grassland will change according to seasonal rainfall, temperature, fire and management. The TEC occurs on plains with a slope less than 5 degrees. The communities have very few trees or shrubs, but will have a diversity of herb species including legumes, orchids, daisies and lilies (OEH 2014).

Photograph 2.1 Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland TEC

2.1.3 Known distribution

The Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Queensland TEC can be found on the Liverpool Plains and the Moree Plains of NSW and the Darling Downs of Queensland (OEH 2014) (refer Figure 2.1).

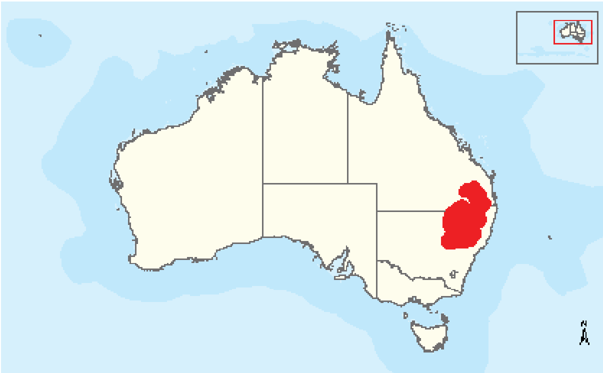


Figure 2.1 **Distribution range of Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland TEC**

Source: DotEE (2019)

2.1.4 Threatening processes

The following have been identified as potentially threatening processes to Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Queensland TEC:

- Clearing for cropping and mining
- Grazing by introduced livestock
- Weed invasion
- Changed flood regimes
- Changed fire regimes
- Feral animals such as pigs (OEH 2014).

2.1.5 Community resilience

Determination of species resilience is presented in Table 2.1.

2.1.6 References

Department of the Environment and Energy (2019). Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=88 [Accessed 3 September 2019].

Office of Environment and Heritage, NSW (2014). Natural Grasslands on Alluvial Plains. Available from: https://northerntablelands.lls.nsw.gov.au/__data/assets/pdf_file/0003/542559/TECfact-NaturalGrassland-LLS.pdf [Accessed 3 September 2019].

Threatened Species Scientific Committee (2010). Advice to the Minister for the Environment, Heritage and the Arts from the Threatened Species Scientific Committee (the Committee) on an Amendment to the list of Threatened Ecological Communities under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* [Accessed 3 September 2019].

Table 2.1 Community resilience questionnaire – Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Queensland

Item	Question	Criteria	Community response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target community expected to change as a result of the projected changes?	Community's threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes **(2)** ▪ Unlikely to change as a result of the projected changes **(0)**	Threatening processes are expected to intensify as a result of projected changes	2
Q2.	Area and distribution: Are areas or locations of the associated vegetation type associated with this community expected to change?	Areas or locations of the associated vegetation type associated with this community expected to: ▪ Decline or shift from current location **(4)** ▪ Stay the same and in approximately the same location **(0)**	Area used for non-breeding habitat expected to decline or shift from current location	4
Q3.	Habitat components: Are other specific habitat components required by this community expected to change?	Specific habitat components required by this community: ▪ Expected to decrease or habitat components required for non-breeding unknown **(4)** ▪ Unlikely to change **(0)**	Required non-breeding habitat components expected to decrease	4
Q4.	Survival during resource fluctuation: Does this community have alternative strategies/ pathways to cope with variable resources or climate conditions?	Community has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(3)** ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)**	Community has flexible strategies to cope with variable resources across multiple years	0
Q5.	Resources: Are important resources for this community expected to change?	▪ Primary resources are expected to be negatively impacted by projected changes **(4)** ▪ Primary resources are not expected to be impacted by projected changes **(0)**	Primary resources are not expected to be impacted by projected changes	0
Q6.	Susceptibility to negative impacts: Is the community's susceptibility to negative impacts expected to change?	▪ Susceptibility to impacts: – Is expected to increase as a result of the projected changes **(4)** – Is not expected to be impacted by the projected changes **(0)**	Community susceptibility to impacts is expected increase as a result of the projected changes	4

Item	Question	Criteria	Community response	Score
Q7.	Disease: Is prevalence of diseases known to cause widespread mortality in this community expected to change?	- Disease prevalence is expected increase with projected changes **(3)** - No known effects of expected changes on disease prevalence (0)	No known effects of expected changes on disease prevalence	0
Q8.	Competitors: Are populations of important competing species expected to change?	- Major competitor species are expected to be positively impacted by projected changes **(3)** - Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)**	Major competitor species such as exotic grasses are expected to be positively impacted by projected changes	3
Total score				17
Community resilience				Moderate

2.2 Brigalow (Acacia harpophylla dominant and co-dominant)

2.2.1 Status

EPBC Act – Endangered

BC Act - Endangered

2.2.2 Ecology

Characteristics and defining features

Brigalow Threatened Ecological Community (TEC) is a low woodlands or forest communities dominated by Brigalow (*Acacia harpophylla*), with pockets of Belah (*Casuarina cristata*) and Poplar Box (*Eucalyptus populnea* subsp. *bimbil*). The canopy tends to be quite dense and the understorey and ground cover are only sparse (refer Photograph 2.2). The height of the tree layer varies from about 9 m in low rainfall areas (averaging around 500 mm per annum) to around 25 m in higher rainfall areas (averaging around 750 mm per annum). This community has been extensively cleared for agriculture, with most surviving remnants along roadsides and paddock edges (Butler 2007; OEH 2019).

Photograph 2.2 Brigalow TEC

2.2.3 Known distribution

Brigalow TEC extend from south of Charters Towers in Queensland, in a broad swathe east of Blackall, Charleville and Cunnamulla, south to northern NSW near Narrabri and Bourke (refer Figure 2.2). In Queensland, it occurs predominantly within the Brigalow Belt North, Brigalow Belt South, Darling Riverine Plains and Southeast Queensland bioregions. In NSW, remnants of Brigalow TEC mostly occur north of Burke, west of Narrabri and north of Moree (Butler 2007).

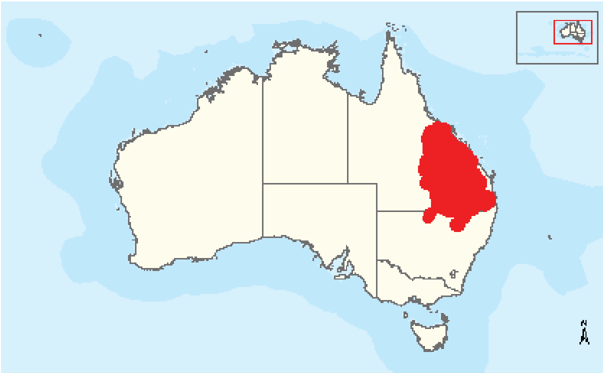


Figure 2.2 Distribution range of Brigalow TEC

Source: DotEE (2019)

2.2.4 Threatening processes

The following have been identified as potentially threatening processes to Brigalow TEC:

- Land clearing and fragmentation
- Invasion and establishment of weed species
- Overgrazing by domestic stock
- Changes in hydrological regimes
- Spray drift of herbicides and pesticides
- Fragmentation resulting in edge effects and risk of loss of small, scattered remnants
- Clearing and damage from road and rail maintenance activities
- Lack of viability of seed set
- Lack of pollinators
- Logging for fence posts.

2.2.5 Community resilience

Determination of species resilience is presented in Table 2.2.

2.2.6 References

Butler, D.W. (2007). Recovery plan for the "Brigalow (*Acacia harpophylla* dominant and co-dominant" endangered ecological community (draft of 1 May 2007). Report to the Department of the Environment and Water Resources, Canberra. Queensland National Parks and Wildlife Service, Brisbane.

Department of the Environment and Energy (2019). Brigalow (*Acacia harpophylla* dominant and co-dominant) in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=28 [Accessed 31 August 2019].

Table 2.2 **Species resilience questionnaire – Brigalow (Acacia harpophylla dominant and co-dominant)**

Item	Question	Criteria	Community response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target community expected to change as a result of the projected changes?	Community's threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes **(2)** ▪ Unlikely to change as a result of the projected changes **(0)**	Threatening processes are expected to intensify as a result of projected changes	2
Q2.	Area and distribution: Are areas or locations of the associated vegetation type associated with this community expected to change?	Areas or locations of the associated vegetation type associated with this community expected to: ▪ Decline or shift from current location **(4)** ▪ Stay the same and in approximately the same location **(0)**	Area used for non-breeding habitat expected to decline or shift from current location	4
Q3.	Habitat components: Are other specific habitat components required by this community expected to change?	Specific habitat components required by this community: ▪ Expected to decrease or habitat components required for non-breeding unknown **(4)** ▪ Unlikely to change **(0)**	Required non-breeding habitat components expected to decrease	4
Q4.	Survival during resource fluctuation: Does this community have alternative strategies/ pathways to cope with variable resources or climate conditions?	Community has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(3)** ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)**	Community has flexible strategies to cope with variable resources across multiple years	0
Q5.	Resources: Are important resources for this community expected to change?	▪ Primary resources are expected to be negatively impacted by projected changes **(4)** ▪ Primary resources are not expected to be impacted by projected changes **(0)**	Primary resources are not expected to be impacted by projected changes	0
Q6.	Susceptibility to negative impacts: Is the community's susceptibility to negative impacts expected to change?	▪ Susceptibility to impacts: – Is expected to increase as a result of the projected changes **(4)** – Is not expected to be impacted by the projected changes **(0)**	Community susceptibility to impacts is not expected to be impacted by the projected changes	0

Item	Question	Criteria	Community response	Score
Q7.	Disease: Is prevalence of diseases known to cause widespread mortality in this community expected to change?	▪ Disease prevalence is expected increase with projected changes **(3)** ▪ No known effects of expected changes on disease prevalence (0)	No known effects of expected changes on disease prevalence	0
Q8.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes **(3)** ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)**	No expected impacts of projected changes in major competitor species	0
Total score				10
Community resilience				Moderate

Office of Environment and Heritage, NSW (2017). Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions. Available from: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10109 [Accessed 31 August 2019].

Threatened Species Scientific Committee (2001). Brigalow (*Acacia harpophylla* dominant and co-dominant), advice to the Minister for the Environment and Water Resources from the Threatened Species Scientific Committee on a public nomination for an ecological community listing on the *Environment Protection and Biodiversity Conservation Act 1999* [Accessed 31 August 2019].

2.3 Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions

2.3.1 Status

EPBC Act – Endangered

BC Act - Endangered

2.3.2 Ecology

Characteristics and defining features

Coolibah – Black Box woodland TEC is associated with floodplains and drainage areas. This TEC is defined as woodlands dominated by *Eucalyptus coolabah* subsp. *coolabah* and/or *Eucalyptus largiflorens* (Black box) with a grassy understory. Suitable soil for this TEC is grey, self-mulching clays of periodically waterlogged floodplains, swamp margins, ephemeral wetlands and stream banks (NSW Scientific Committee 2009). The TEC occurs a climatic zone with a summer dominated rainfall averaging 250 to 700 mm per year. The vegetative community provides characteristic habitat features of value to particular fauna, including a grassy understorey with scattered fallen logs, areas of deep-cracking clay soils, patches of thick regenerating Eucalyptus saplings, and large trees containing a diverse bark and foliage foraging resource and an abundance of small and large hollows. The fertile and relatively mesic environment of these woodlands provides essential resources for the persistence of fauna in the semi-arid region, supports a wide range of declining woodland birds and provides important nesting sites for colonial breeding waterbirds. (OEH 2019).

Photograph 2.3 Coolibah – Black Box woodland TEC

Source: DotEE (2019)

2.3.3 Known distribution

Coolibah – Black Box woodland TEC is restricted to the upper reaches of the Murray-Darling Basin and southern part of the Fitzroy River system within the Darling Riverine Plains and Brigalow Belt South Bioregions (DotEE 2019) (refer Figure 2.3).

Figure 2.3 Distribution range of Coolibah – Black Box woodland TEC

Source: DotEE (2019)

2.3.4 Threatening processes

The following have been identified as potentially threatening processes to Coolibah – Black Box woodland TEC:

- Clearing
- Fragmentation
- Changes to hydrology
- Inappropriate grazing regimes
- Weed invasion
- Low level of protection in reserves (DotEE 2019).

2.3.5 Community resilience

Determination of species resilience is presented in Table 2.3.

2.3.6 References

Department of the Environment (2019). Coolibah – Black Box Woodlands of the darling Riverine Plains and the Brigalow Belt South Bioregions in Community and Species Profile and Threats Database. Department of the Environment. Canberra. Available from: http://www.environment.gov.au/sprat [Accessed 19 August 2019].

NSW Scientific Committee (New South Wales Scientific Committee) (2009). Coolibah – Black Box Woodland of the northern riverine plains in the Darling Riverine Plains and Brigalow Belt South Bioregions – reject delisting of ecological community [Accessed 19 August 2019].

Office of Environment and Heritage (2019). Threatened biodiversity profile search - Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions – profile. Available from: https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10175 [Accessed 18 September 2019].

Table 2.3 Species resilience questionnaire – Coolibah – Black Box Woodland TEC

Item	Question	Criteria	Community response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target community expected to change as a result of the projected changes?	Community's threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes **(2)** ▪ Unlikely to change as a result of the projected changes **(0)**	Threatening processes are expected to intensify as a result of projected changes	2
Q2.	Area and distribution: Are areas or locations of the associated vegetation type associated with this community expected to change?	Areas or locations of the associated vegetation type associated with this community expected to: ▪ Decline or shift from current location **(4)** ▪ Stay the same and in approximately the same location **(0)**	Area used for non-breeding habitat expected to decline or shift from current location	4
Q3.	Habitat components: Are other specific habitat components required by this community expected to change?	Specific habitat components required by this community: ▪ Expected to decrease or habitat components required for non-breeding unknown **(4)** ▪ Unlikely to change **(0)**	Required non-breeding habitat components expected to decrease	4
Q4.	Survival during resource fluctuation: Does this community have alternative strategies/ pathways to cope with variable resources or climate conditions?	Community has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(3)** ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)**	Community has flexible strategies to cope with variable resources across multiple years	0
Q5.	Resources: Are important resources for this community expected to change?	▪ Primary resources are expected to be negatively impacted by projected changes **(4)** ▪ Primary resources are not expected to be impacted by projected changes **(0)**	Primary resources are not expected to be impacted by projected changes	0
Q6.	Susceptibility to negative impacts: Is the community's susceptibility to negative impacts expected to change?	▪ Susceptibility to impacts: – Is expected to increase as a result of the projected changes **(4)** – Is not expected to be impacted by the projected changes **(0)**	Community susceptibility to impacts is not expected to be impacted by the projected changes	0

Item	Question	Criteria	Community response	Score
Q7.	Disease: Is prevalence of diseases known to cause widespread mortality in this community expected to change?	▪ Disease prevalence is expected increase with projected changes **(3)** ▪ No known effects of expected changes on disease prevalence (0)	No known effects of expected changes on disease prevalence	0
Q8.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes **(3)** ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)**	No expected impacts of projected changes in major competitor species	0
Total score				10
Community resilience				Moderate

2.4 Poplar Box Grassy Woodland on Alluvial Plains

2.4.1 Status

EPBC Act status - Endangered

2.4.2 Ecology

Characteristics and defining features

Poplar box grassy woodland on alluvial plains TEC occurs as a grassy woodland dominated by *Eucalyptus populnea* (Poplar box) (DOTE 2019). This TEC typically occurs on flat to gently undulated topography with a range of alluvial soils Webb 1980. Suitable soils include ancient and recent depositional alluvial plains with clay, clay-loam, and sandy loam, typically duplex sols or sodosols (Fensham et al. 2017). The understory is typically not shrubby and is dominated by native grasses and herbs (DOTE 2019). In NSW it is associated with Plant Community Types (PCTs) 56 and 244.

Photograph 2.4 Poplar Box Grassy Woodland on Alluvial Soils TEC

Source: Aurecon (2019)

2.4.3 Known distribution

Poplar box grassy woodland TEC occurs west of the Great Dividing Range, below 300 m above sea level (ASL) and between latitudes 20°S to 34°S. The TEC exists within the Brigalow Belt (North and South), Southeast Queensland, Cobar peneplain, Darling Riverine Plains, NSW South Western Slopes and Riverina IBRA bioregions (DotEE 2019).

Figure 2.4 **Distribution range of Poplar Box Grassy Woodland on Alluvial Soils TEC**

Source: DotEE 2019

2.4.4 Threatening processes

The following have been identified as potentially threatening processes to Poplar box grassy woodland TEC:

- Aggressive exclusion of birds from potential woodland and forest habitat by over-abundant noisy miners (*Manorina melanocephala*)
- Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases
- Land clearance
- Competition and land degradation by rabbits
- Competition and land degradation by unmanaged goats
- Novel biota and their impact on biodiversity
- Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*)
- Psittacine circoviral (beak and feather) Disease affecting endangered psittacine species
- The biological effects, including lethal toxic ingestion, caused by Cane Toads (*Bufo marinus*)
- Invasion of northern Australia by Gamba Grass and other introduced grasses
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants
- Predation by European red fox
- Predation by feral cats
- Predation, habitat degradation, competition and disease transmission by feral pigs (DotEE 2019).

2.4.5 Community resilience

Determination of species resilience is presented in Table 2.3.

Table 2.4 Species resilience questionnaire – Poplar Box Grassy Woodland on Alluvial Plains TEC

Item	Question	Criteria	Community response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target community expected to change as a result of the projected changes?	Community's threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes **(2)** ▪ Unlikely to change as a result of the projected changes **(0)**	Threatening processes are expected to intensify as a result of projected changes	2
Q2.	Area and distribution: Are areas or locations of the associated vegetation type associated with this community expected to change?	Areas or locations of the associated vegetation type associated with this community expected to: ▪ Decline or shift from current location **(4)** ▪ Stay the same and in approximately the same location **(0)**	Area used for non-breeding habitat expected to decline or shift from current location	4
Q3.	Habitat components: Are other specific habitat components required by this community expected to change?	Specific habitat components required by this community: ▪ Expected to decrease or habitat components required for non-breeding unknown **(4)** ▪ Unlikely to change **(0)**	Required non-breeding habitat components expected to decrease	4
Q4.	Survival during resource fluctuation: Does this community have alternative strategies/ pathways to cope with variable resources or climate conditions?	Community has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(3)** ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)**	Community has flexible strategies to cope with variable resources across multiple years	0
Q5.	Resources: Are important resources for this community expected to change?	▪ Primary resources are expected to be negatively impacted by projected changes **(4)** ▪ Primary resources are not expected to be impacted by projected changes **(0)**	Primary resources are not expected to be impacted by projected changes	0
Q6.	Susceptibility to negative impacts: Is the community's susceptibility to negative impacts expected to change?	▪ Susceptibility to impacts: – Is expected to increase as a result of the projected changes **(4)** – Is not expected to be impacted by the projected changes **(0)**	Community susceptibility to impacts is not expected to be impacted by the projected changes	0

Item	Question	Criteria	Community response	Score
Q7.	Disease: Is prevalence of diseases known to cause widespread mortality in this community expected to change?	■ Disease prevalence is expected increase with projected changes **(3)** ■ No known effects of expected changes on disease prevalence (0)	No known effects of expected changes on disease prevalence	0
Q8.	Competitors: Are populations of important competing species expected to change?	■ Major competitor species are expected to be positively impacted by projected changes **(3)** ■ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)**	No expected impacts of projected changes in major competitor species	0
Total score				10
Community resilience				Moderate

2.4.6 References

Department of the Environment and Energy (2019). Polar Box Grassy Woodland on Alluvial Plains in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=141&status=Endangered [Accessed 13 September 2019].

Fensham. R., Biggs. A., Butler. D., MacDermott. H. (2017) Brigalow forests and associated eucalypt woodlands of subtropical eastern Australia, in D.A. Keith (ed), Australian vegetation. Cambridge University Press, Cambridge, pp 389-409.

Webb. A., Walker. P., Gunn. H., Mortlock, A. (1980) 'Soils of the Poplar Box (*Eucalyptus populnea*) communities of eastern Australia', *Australia Rangelands Journal*, vol 2, pp 17–30.

2.5 Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions

2.5.1 Status

EPBC Act status – Endangered

BC Act - Endangered

2.5.2 Ecology

Characteristics and defining features

Semi-evergreen vine thicket TEC is considered an extreme form of dry seasonal subtropical rainforest. It is generally characterised by the prominence of trees with microphyll sized leaves and the presence of Bottle trees (*Brachychiton* spp.) as emergent. Semi-evergreen vine thicket TEC are generally less than 10 m high, made up of vines and rainforest trees as well as some shrubs. The main canopy is dominated by rainforest species such as Red olive plum (*Cassine australis var. angustifolia*), Wilga (*Geijera parvifolia*), Native olive (*Notelaea microcarpa var. microcarpa*) and Peach bush (*Ehretia membranifolia*). Currant bush (*Carissa ovata*) is often present and typical vines include Gargaloo (*Parsonsia eucalytophylla*) and Wonga vine (*Pandorea pandorana*). The thickets occur in areas with a subtropical, seasonally dry climate on soils of high to medium fertility. It is common on undulating plains on fine grained sedimentary rocks (frequently shale) and on basalt hills and plains (DOTE 2019; OEH 2019; McDonald 1996).

Photograph 2.5 **Semi Evergreen Vine Thicket TEC**

Source: Aurecon (2019)

2.5.3 Known distribution

Semi-evergreen vine thicket TEC extend from the Townsville area in Queensland to northern NSW. In Queensland, the remnant patches are mostly scattered from coastal dunes and river deltas through the northern and central parts of the Brigalow Belt Bioregion to its south eastern parts between Jandowae and Killarney on the Queensland/NSW border (Queensland Herbarium 2002). Within NSW it is found in small patches from south east of Boggabilla to south west of Scone.

Figure 2.5 **Distribution range of SEVT TEC**

Source: DotEE 2019

2.5.4 Threatening processes

There are a range of threatening process listed for this TEC they include:

- Clearing of habitat for agriculture and grazing.
- Grazing and trampling by domestic stock.
- Clearing and damage to habitat by road maintenance works.
- Fragmentation and risk of extinction due to small, scattered remnants

- Lack of value and understanding of the TEC by landholders and managers of the TEC
- Overbrowsing by both domestic and wild goats
- Risk of fire both wildlife and hazard reduction burns
- Climate change leading to longer dry periods altering vegetation structure and composition
- Invasion and establishment of weed species changing community structure and floristic composition, particularly Green Panic Grass, Sabi Grass, Tiger Pear, and Tree Pear.
- Fox predation on Brush Turkeys
- Impact of pigs on Brush Turkeys and on germination of key plant species through consumption of fruit
- Increase in goannas, caused by dumping of carcasses, leading to higher mortality rates of brush turkeys.

2.5.5 Community resilience

Determination of species resilience is presented in Table 2.5.

2.5.6 References

Department of the Environment (2019). Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions in Community and Species Profile and Threats Database, Department of the Environment, Canberra. Available from: **http://www.environment.gov.au/sprat**. Accessed 2019-09-13T18:21:58AEST.

Office of Environment and Heritage, NSW (2017). Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions - profile. Available from: https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10749 [Accessed 17 September 2019].

McDonald, W.J.F. (1996). *Spatial and temporal patterns in the dry season subtropcial rainforests of eastern Australia, with particular reference to the vine thickets of central and southern Queensland*. PhD thesis, Botany Department, University of New England.

Queensland Herbarium (2002). Environment Protection and Biodiversity Conservation Act Threatened ecological communities 1997 remnant. Unpublished map, Queensland Herbarium, Brisbane.

Table 2.5 Species resilience questionnaire – Semi-evergreen vine thickets TEC

Item	Question	Criteria	Community response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target community expected to change as a result of the projected changes?	Community's threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes **(2)** ▪ Unlikely to change as a result of the projected changes **(0)**	Threatening processes are expected to intensify as a result of projected changes	2
Q2.	Area and distribution: Are areas or locations of the associated vegetation type associated with this community expected to change?	Areas or locations of the associated vegetation type associated with this community expected to: ▪ Decline or shift from current location **(4)** ▪ Stay the same and in approximately the same location **(0)**	Area used for non-breeding habitat expected to decline or shift from current location	4
Q3.	Habitat components: Are other specific habitat components required by this community expected to change?	Specific habitat components required by this community: ▪ Expected to decrease or habitat components required for non-breeding unknown **(4)** ▪ Unlikely to change **(0)**	Required non-breeding habitat components expected to decrease	4
Q4.	Survival during resource fluctuation: Does this community have alternative strategies/ pathways to cope with variable resources or climate conditions?	Community has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(3)** ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)**	Community has flexible strategies to cope with variable resources across multiple years	0
Q5.	Resources: Are important resources for this community expected to change?	▪ Primary resources are expected to be negatively impacted by projected changes **(4)** ▪ Primary resources are not expected to be impacted by projected changes **(0)**	Primary resources are not expected to be impacted by projected changes	0
Q6.	Susceptibility to negative impacts: Is the community's susceptibility to negative impacts expected to change?	▪ Susceptibility to impacts: – Is expected to increase as a result of the projected changes **(4)** – Is not expected to be impacted by the projected changes **(0)**	Community susceptibility to impacts is not expected to be impacted by the projected changes	0

Item	Question	Criteria	Community response	Score
Q7.	Disease: Is prevalence of diseases known to cause widespread mortality in this community expected to change?	▪ Disease prevalence is expected increase with projected changes **(3)** ▪ No known effects of expected changes on disease prevalence (0)	No known effects of expected changes on disease prevalence	0
Q8.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes **(3)** ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)**	No expected impacts of projected changes in major competitor species	0
Total score				10
Community resilience				Moderate

2.6 Weeping Myall woodlands

2.6.1 Status

EPBC Act – Endangered

BC Act - Endagnered

2.6.2 Ecology

Characteristics and defining features

Weeping Myall woodland TEC are predominantly underlain by red-brown earths and heavy textured grey and brown alluvial soils in areas receiving 375 mm to 500 mm of mean annual rainfall. Weeping Myall (*Acacia pendula*) is the dominant overstory flora species due to its ability to undergo regular cycles of senescence and regeneration, making it often the only tree species in a Weeping Myall woodland TEC (OEH 2017b; DEWHA 2009) (refer Photograph 2.6).

The structure of the community varies between low to open woodland and open shrubland. Understorey structure and composition is affected by latitude with areas south of the Lachlan River district featuring a dominant open layer of chenopod shrubs including saltbushes, native cotton bushes and bluebushes. More woody species and summer grasses including Mitchell grass (*Astrebla* spp.), Queensland blue grass (*Dichanthium sericeum*) as well as Wallaby grass (*Austrodanthonia*) species feature in the northern part of the TEC (DEWHA 2009).

Photograph 2.6 Weeping Myall woodland TEC

2.6.3 Known distribution

The TEC is found inland along alluvial plains west of the Great Diving Range in NSW and Queensland. Weeping Myall Woodland is found in natural resource management and catchment management authority regions (refer Figure 2.6), including the:

- Border-Rivers-Gwydir catchment management authority region, NSW
- Border Rivers and Maranoa Balonne natural resource management region, QLD
- Condamine natural resource management region, QLD (DEWHA 2009).

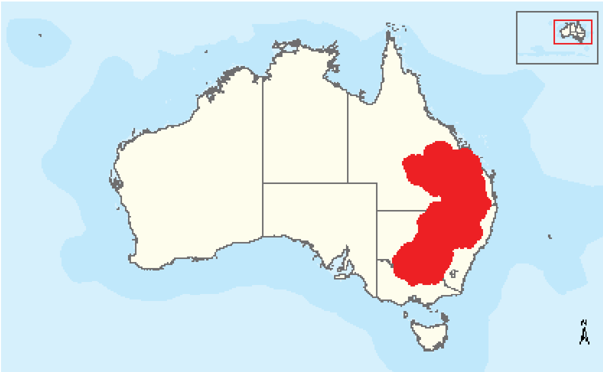


Figure 2.6 **Distribution range of Weeping Myall woodland TEC**

Source: DotEE (2019)

2.6.4 Threatening processes

The following have been identified as potentially threatening processes to Weeping Myall woodland TEC:

- Land clearing due to cropping or agriculture
- Land degradation
- Weed invasion and herbivory by caterpillars (DotEE 2019).

2.6.5 Community resilience

Determination of species resilience is presented in Table 2.6.

2.6.6 References

Department of the Environment (2019). Weeping Myall Woodlands in Community and Species Profile and Threats Database. Department of the Environment. Canberra. Available from: http://www.environment.gov.au/sprat [Accessed 17 September 2019].

Department of the Environment, Water, Heritage and the Arts (2009). Weeping Myall Woodlands. Australian Government. Available from: http://www.environment.gov.au/system/files/resources/a887e6ec-f4db-4476-8e72-977085028dbd/files/weeping-myall-woodlands.pdf [Accessed 17 September 2019].

Office of Environment and Heritage (2017). Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions - profile. New South Wales Government. Available from: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10973 [Accessed 18 September 2019].

Table 2.6 Species resilience questionnaire - Weeping myall woodland TEC

Item	Question	Criteria	Community response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target community expected to change as a result of the projected changes?	Community's threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes **(2)** ▪ Unlikely to change as a result of the projected changes **(0)**	Threatening processes are expected to intensify as a result of projected changes	2
Q2.	Area and distribution: Are areas or locations of the associated vegetation type associated with this community expected to change?	Areas or locations of the associated vegetation type associated with this community expected to: ▪ Decline or shift from current location **(4)** ▪ Stay the same and in approximately the same location **(0)**	Area used for non-breeding habitat expected to decline or shift from current location	4
Q3.	Habitat components: Are other specific habitat components required by this community expected to change?	Specific habitat components required by this community: ▪ Expected to decrease or habitat components required for non-breeding unknown **(4)** ▪ Unlikely to change **(0)**	Required non-breeding habitat components expected to decrease	4
Q4.	Survival during resource fluctuation: Does this community have alternative strategies/ pathways to cope with variable resources or climate conditions?	Community has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(3)** ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)**	Community has flexible strategies to cope with variable resources across multiple years	0
Q5.	Resources: Are important resources for this community expected to change?	▪ Primary resources are expected to be negatively impacted by projected changes **(4)** ▪ Primary resources are not expected to be impacted by projected changes **(0)**	Primary resources are not expected to be impacted by projected changes	0
Q6.	Susceptibility to negative impacts: Is the community's susceptibility to negative impacts expected to change?	▪ Susceptibility to impacts: – Is expected to increase as a result of the projected changes **(4)** – Is not expected to be impacted by the projected changes **(0)**	Community susceptibility to impacts is not expected to be impacted by the projected changes	0

Item	Question	Criteria	Community response	Score
Q7.	Disease: Is prevalence of diseases known to cause widespread mortality in this community expected to change?	▪ Disease prevalence is expected increase with projected changes **(3)** ▪ No known effects of expected changes on disease prevalence (0)	No known effects of expected changes on disease prevalence	0
Q8.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes **(3)** ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)**	No expected impacts of projected changes in major competitor species	0
Total score				10
Community resilience				Moderate

2.7 White Box–Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland

2.7.1 Status

EPBC Act status – Critically endangered

BC Act status – Critically endangered

2.7.2 Ecology

Characteristics and defining features

White box-yellow box-Blakely's red gum grassy woodland and derived native grassland TEC is an open woodland community, which has a tussock grass layer, patchy shrub layer and tree layer predominantly made up of *Eucalyptus albens*, *E. melliodora* and *E. blakelyi*. Intact sites contain a high diversity of trees, shrubs, climbing plants, grasses and especially herbs. Tree cover is generally discontinuous and consists of widely-spaced trees of medium height. This ecological community occurs on moderate to highly fertile soils at altitudes of 170 m to 1,200 m (NSWSC 2002; OEH 2017; Yates and Hobbs 1997).

Photograph 2.7 White box-yellow box-Blakely's red gum grassy woodland TEC

Source: Aurecon (2019)

2.7.3 Known distribution

White box-yellow box-Blakely's red gum grassy woodland and derived native grassland TEC occur in an arc along the western slopes and tablelands of the Great Dividing Range from southern Queensland through NSW to central Victoria (Beadle 1981).

Figure 2.7 **Distribution of White box-yellow box-Blakely's red gum grassy woodland TEC**

Source: DOEE (2019)

2.7.4 Threatening processes

Threatening processes for this TEC include:

- Land clearing
- Grazing
- Dieback
- Salinity
- Weed invasion
- Inappropriate fire regimes (DOTE 2019).

2.7.5 Community resilience

Determination of species resilience is presented in Table 2.7.

2.7.6 References

Beadle, N.C.W. (1981). The Vegetation of Australia. Cambridge University Press, Cambridge.

Department of the Environment and Energy (2019). White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=43 [Accessed 4 September 2019].

NSW Scientific Committee (2002). White Box Yellow Box Blakely's Red Gum Woodland – endangered ecological community listing. Final Determination. Available from: http://www.nationalparks.nsw.gov.au/npws.nsf/content/boxgum+woodland+endangered+ecological+community+listing [Accessed 4 September 2019]

Office of Environment and Heritage, NSW (2019). White Box Yellow Box Blakely's Red Gum Woodland. Available from: https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10837 [Accessed 4 September 2019].

Yates, C.J. and R.J. Hobbs (1997). Temperate Eucalypt Woodlands: a review of their status, processes threatening their persistence and techniques for restoration in Australian Journal of Botany 45: 949-973

Table 2.7 **Community resilience questionnaire - White Box TEC**

Item	Question	Criteria	Community response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target community expected to change as a result of the projected changes?	Community's threatening processes are expected to: ■ Increase in intensity as a result of the projected changes **(2)** ■ Unlikely to change as a result of the projected changes **(0)**	Threatening processes are expected to intensify as a result of projected changes	2
Q2.	Area and distribution: Are areas or locations of the associated vegetation type associated with this community expected to change?	Areas or locations of the associated vegetation type associated with this community expected to: ■ Decline or shift from current location **(4)** ■ Stay the same and in approximately the same location **(0)**	Area used for non-breeding habitat expected to decline or shift from current location	4
Q3.	Habitat components: Are other specific habitat components required by this community expected to change?	Specific habitat components required by this community: ■ Expected to decrease or habitat components required for non-breeding unknown **(4)** ■ Unlikely to change **(0)**	Required non-breeding habitat components expected to decrease	4
Q4.	Survival during resource fluctuation: Does this community have alternative strategies/ pathways to cope with variable resources or climate conditions?	Community has: ■ Limited flexible strategies to cope with variable resources across multiple years **(3)** ■ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)**	Community has flexible strategies to cope with variable resources across multiple years	0
Q5.	Resources: Are important resources for this community expected to change?	■ Primary resources are expected to be negatively impacted by projected changes **(4)** ■ Primary resources are not expected to be impacted by projected changes **(0)**	Primary resources are not expected to be impacted by projected changes	0
Q6.	Susceptibility to negative impacts: Is the community's susceptibility to negative impacts expected to change?	■ Susceptibility to impacts: – Is expected to increase as a result of the projected changes **(4)** – Is not expected to be impacted by the projected changes **(0)**	Community susceptibility to impacts is not expected to be impacted by the projected changes	0

Item	Question	Criteria	Community response	Score
Q7.	Disease: Is prevalence of diseases known to cause widespread mortality in this community expected to change?	▪ Disease prevalence is expected increase with projected changes **(3)** ▪ No known effects of expected changes on disease prevalence (0)	No known effects of expected changes on disease prevalence	0
Q8.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes **(3)** ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)**	No expected impacts of projected changes in major competitor species	0
Total score				10
Community resilience				Moderate

3 Endangered flora species

3.1 *Tylophora linearis* – (Tylophora linearis)

3.1.1 Status

EPBC Act – Endangered

BC Act – Vulnerable

3.1.2 Biology and ecology

Characteristics

Tylophora linearis is a slender, almost hairless twiner with a clear sap. Its leaves are dark green, linear and 1 to 5 cm x 0.5 to 3 mm. The flowers are purplish, 3 to 6 mm in diameter, hairy and in radiating groups of three to eight (refer Photograph 3.1). The fruit is cigar shaped, hairless, up to 100 mm long and approximately 5 mm diameter (OEH 2019).

Photograph 3.1 ***Tylophora linearis***

Source: Carr (n.d.)

Known distribution

There are records of *T. linearis* from Goonoo, Pillaga West, Pillaga East, Bibblewindi, Cumbil and Eura State Forests, Coolbaggie Nature Reserve, Goobang National Park and Beni Strategic Cropping Area. There has also been records near Glenmorgan in the western Darling Downs, Queensland (OEH 2017) (refer Figure 3.1).

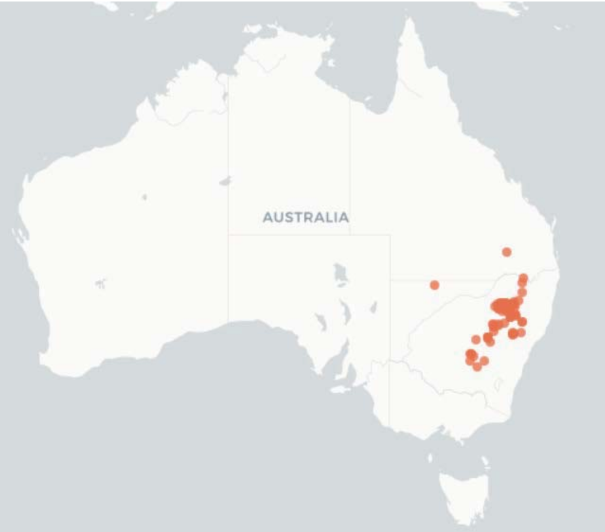


Figure 3.1 **Distribution range of *T. linearis***

Source: ALA (2019)

Biology and reproduction

Tylophora linearis flowers in spring, with flowers recorded in November or May with fruiting probably 2 to 3 months later (OEH 2019).

3.1.3 Habitat

Tylophora linearis grows in dry scrub and open forest. It has been recorded in low-altitude sedimentary flats in dry woodlands of *Eucalyptus fibrosa, Eucalyptus sideroxylon, Eucalyptus albens, Callitris endlicheri, Callitris glaucophylla* and *Allocasuarina luehmannii*. It also grows in association with *Acacia hakeoides, Acacia lineata, Melaleuca uncinata, Myoporum* species and *Casuarina* species (OEH 2019).

3.1.4 Threatening processes

The following have been identified as potentially threatening processes to *T. linearis*:

- Track maintenance
- Forestry activities
- Inappropriate disturbance regimes (OEH 2019).

3.1.5 Species resilience

Determination of species resilience is presented in Table 3.1.

Table 3.1 **Species resilience questionnaire – *Tylophora linearis***

Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: - Increase in intensity as a result of the projected changes (2) - Unlikely to change as a result of the projected changes (0) - Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Major threats to the species include: - Track maintenance - Forestry activities - Inappropriate disturbance regimes (OEH 2017). Extended drought periods and other forms of land degradation Project works are unlikely to Increase in intensity as a result of the projected changes.	0
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: - Decline or shift from current location (3) - Stay the same and in approximately the same location (0) - Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Project works are unlikely to result in a shift or decline in the current breeding habitat for this species	0
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: - Decline or shift from current location (2) - Stay the same and in approximately the same location (0) - Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Project works are likely to reduce the area of occupancy of this species as extant individual are unable to move from their fixed locations.	2
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: - Expected to decrease or habitat components required for breeding unknown (3) - Unlikely to change (0) - Due to species sensitivities, any impact on this value is expected to have a adverse impact on the species (120)	Habitat components required for breeding are not expected to change as a result of the project.	0

Item	Question	Criteria	Species response	Score
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ▪ Expected to decrease or habitat components required for non-breeding unknown (2) ▪ Unlikely to change (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Non-breeding habitat components are expected to reduce in size from their current extent.	2
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	▪ Low ability to disperse (2) ▪ Mobile, but dispersal is sex-biased (only one sex disperses) (1) ▪ Very mobile, both sexes disperse (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	The species is restricted to specific habitat types and uses seeds to disperse. Seed may be spread by mechanisms such as soil or water movement. Growing plants are unable to disperse	2
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	▪ Species migratory habitats will be adversely affected (2) ▪ Species migratory habitats will not be adversely affected (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	No, the species does not migrate	0
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ▪ Limited flexible strategies to cope with variable resources across multiple years (2) ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	The species has limited flexible strategies (i.e. production of spores) to cope with resource variation across years	2
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ▪ Once per year or less (2) ▪ More than once per year (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	The species produces multiple times within a defined period within a year and has the capacity to reproduce vegetatively.	0

Item	Question	Criteria	Species response	Score
Q10.	Food resources: Are important food resources for this species expected to change?	▪ Primary food source(s) are expected to be negatively impacted by projected changes (2) ▪ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	This species has the ability to produce its own food (photosensitise). No impacts are expected associated with food availability.	0
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: ▪ Is expected to increase as a result of the projected changes (2) ▪ Is not expected to be impacted by the projected changes (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Predation to this species (grazing) Is not expected to be impacted by the projected changes	0
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	▪ Disease prevalence is expected increase with projected changes (2) ▪ No known effects of expected changes on disease prevalence (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	There are no known effects expected to this species in relation to disease or the prevalence of disease	0
Q13.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes (2) ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species	0
Total score				**8**
Species resilience				**Moderate**

3.1.6 References

Atlas of Living Australia (2019). *Tylophora linearis*. Available from: https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2906372# [Accessed 17 September 2019].

Carr G. (n.d.). Flowers, buds and foliage, *Tylophora linearis*. (Image) [Online] Available from: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10815 [Accessed 17 September 2019].

Office of Environment and Heritage, NSW (2017). *Tylophora linearis*. Available from: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10815 [Accessed 17 September 2019].

4 Vulnerable flora species

4.1 *Thesium australe* - (Austral toadflax)

4.1.1 Status

EPBC Act – Vulnerable

BC Act - Vulnerable

4.1.2 Biology and ecology

Characteristics

Austral toadflax is a small, straggling herb to 40 cm tall. Leaves are pale green to yellow-green, somewhat succulent, 1 to 4 cm long and 0.5 to 1.5 mm wide. Flowers are minute and white, emerging where the leaves meet the stems and appearing in spring. The fruit is small and nut-like, developing in summer. This species is often hidden amongst grasses and herbs. The species is most usually associated with Kangaroo grass on which it is semi-parasitic (OEH 2019, DotEE 2019).

Photograph 4.1 Austral toadflax (*Thesium australe*)

Source: Hunter (2018)

Known distribution

Austral toadflax occurs in New South Wales, the Australian Capital Territory, Queensland and Victoria (Scarlett et al. 2003; OEH 2013). Its current distribution is sporadic but widespread occurring between the Bunya Mountains in south-east Queensland to north-east Victoria (Scarlett et al. 2003) and as far inland as the southern, central and northern tablelands in New South Wales and the Toowoomba region (ALA 2013). The austral toadflax has been recorded once in Tasmania from the Derwent River valley in 1804, and is considered extinct in the state (DPIWE 2003). The Atlas of Living Australia (ALA 2013) indicates that there were 255 Austral toadflax herbarium collections between 1990 and 2013 in New South Wales (NSW) and the Australian Capital Territory. Over 200 of these were in the Nandewar, New England Tablelands and NSW North Coast Bioregions. In northern NSW, survey training lead to a significant increase in the discovery of new sites. Many historic sites do not have recent records (Leigh et al. 1984; ALA 2013).

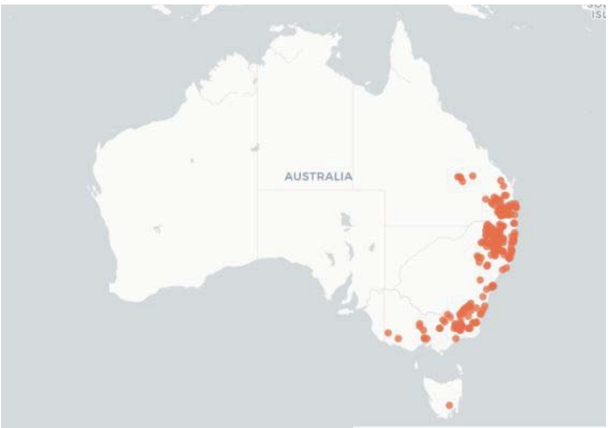


Figure 4.1 **Distribution range of *Thesium australe***

Source: ALA (2019)

4.1.3 Habitat

Within NSW the species occurs in grassland on coastal headlands or grassland and grassy woodland away from the coast. Austral Toad-flax is found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. Although originally described from material collected in the SW Sydney area, populations have not been seen in a long time.

4.1.4 Threatening processes

Threatening processes for the species include:

- Loss and degradation of habitat and/or populations for residential, infrastructure and agricultural developments
- Lack of fire disturbance which causes thickening of the lower, mid and upper stratum reducing speices diversity within the lower stratum ((Scarlett et al. 2003; Cohn 2004)
- Loss and degradation of habitat and/or populations by intensification of grazing regimes
- Loss and degradation of habitat and/or populations by invasion of weeds
- Loss and degradation of habitat and/or populations from infrastructure maintenance (rail and road particularly widening or re-routing(OEH 213)).

4.1.5 Species resilience

Determination of species resilience is presented in Table 4.1.

Table 4.1 Species resilience questionnaire – Austral toadflax (*Thesium australe*)

Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes (2) ▪ Unlikely to change as a result of the projected changes (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Threatening processes to this species include: ▪ Heavy grazing by domestic stock and pest species ▪ Loss of grassland habitat to cultivation ▪ Invasion of grassland habitat by weeds ▪ Increased salinisation ▪ Frequent fires may directly affect plants or alter the habitat in which it grows ▪ Urban developments and the expansion of townships (OEH 2017). Vegetation clearing works within areas of species habitat are considered likely to contribute to threatening processes for the species via habitat clearance and fragmentation and increased predation vulnerability.	2
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ▪ Decline or shift from current location (3) ▪ Stay the same and in approximately the same location (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	This species is a grassland specialist and reproduces via seed set. No impacts to species reproductive ability is anticipated.	0
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ▪ Decline or shift from current location (2) ▪ Stay the same and in approximately the same location (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	The area or location of the associated vegetation type used for non-breeding activities by this species expected to stay the same and in approximately the same location	0

Item	Question	Criteria	Species response	Score
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Unlikely to change (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Breeding habitats are not expected to change as a result of the proposed activities	0
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ▪ Expected to decrease or habitat components required for non-breeding unknown (2) ▪ Unlikely to change (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Other specific habitat components required for survival during non-breeding periods are not expected to change within the associated vegetation type for this species	0
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	▪ Low ability to disperse (2) ▪ Mobile, but dispersal is sex-biased (only one sex disperses) (1) ▪ Very mobile, both sexes disperse (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	This species disperses via seed. Dispersal mechanisms are well developed in this species	0
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	▪ Species migratory habitats will be adversely affected (2) ▪ Species migratory habitats will not be adversely affected (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	The species does not migrate and as such there is unlikely to be any deviation from the current state	0

Item	Question	Criteria	Species response	Score
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ▪ Limited flexible strategies to cope with variable resources across multiple years (2) ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	During adverse conditions, this species may persist as a seed in the soil seed bank. Whilst growing plants are adaptable in relation to growing conditions, drought or earth-works are likely to result in the death of plants.	2
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ▪ Once per year or less (2) ▪ More than once per year (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	The species reproduces (via seed) during a single period.	2
Q10.	Food resources: Are important food resources for this species expected to change?	▪ Primary food source(s) are expected to be negatively impacted by projected changes (2) ▪ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	This species has the ability to produce its own food (photosensitise). No impacts are expected associated with food availability.	0
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: ▪ Is expected to increase as a result of the projected changes (2) ▪ Is not expected to be impacted by the projected changes (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Predation to this species (e.g. grazing) Is not expected to be impacted by the projected changes	0

Item	Question	Criteria	Species response	Score
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	▪ Disease prevalence is expected increase with projected changes (2) ▪ No known effects of expected changes on disease prevalence (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	There are no known effects expected to this species in relation to disease or the prevalence of disease	0
Q13.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes (2) ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Species has a variety of competitive relationships; however, disturbance may increase the number of competitive non-native grasses that have the ability to out-compete this species.	2
Total score				8
Species resilience				**Moderate**

4.1.6 References

Atlas of Living Australia (2019). Tylophora linearis. Available from: https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2906372# [Accessed 17 September 2019].

Department of Environment and Energy 2013, *Approved Conservation Advice for Thesium australe (Austral toadflax)* Viewed on line at: http://www.environment.gov.au/biodiversity/threatened/species/pubs/15202-conservation-advice.pdf on 17 September 2019.

Eddy,D., Mallinson,D., Rehwinkel,R., Sharp,S. 2011. *Grassland Flora: A field guide for the Southern Tablelands (NSW & ACT)*. Union Offset Printers.

Hunter, J. Atlas of Living Australia (2018). *Thesium australe*. [image] [online] Available from: https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2891975#gallery [Accessed 13 September 2019].

Leigh J, Boden R and Briggs J (1984). *Extinct and Endangered Plants of Australia*. Melbourne, Victoria: Macmillan

Office of Environment and Heritage, NSW (2019). Tylophora linearis. Available from: ttps://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10815]

Scarlett NH, Branwell M and Earl G (2003). Action Statement No. 56 Austral Toad-flax Thesium australe. Melbourne, Victoria: Department of Sustainability and Environment. Viewed: 20 August 2013 Available at: https://www.environment.vic.gov.au/__data/assets/pdf_file/0023/32567/Austral_Toad-flax_Thesium_australe.pdf [Viewed 18 September 2019]

4.2 *Swainsona murrayana* – (Slender Darling-pea)

4.2.1 Status

EPBC Act – Vulnerable

BC Act – Vulnerable

4.2.2 Biology and ecology

Characteristics

Slender Darling-pea (*Swainsona murrayana*) is a prostrate, somewhat erect perennial herb growing up to 25 cm tall with densely pubescent stems. The leaves are about 5 to 10 cm long, with 3 to 11 leaflets that are 5 to 30 mm long and 1 to 2 mm wide. The flowers are up to 10 mm long and pea-like with the keel a solid pink and the standard petals typically striped pink and white (refer Photograph 4.2). It is distinguished by the strongly twisted hypanthium and keel with retracted tip (DSE 2007; Harden 1991; Jeanes 1996; OEH 2019).

Photograph 4.2 **Slender Darling-pea (*Swainsona murrayana*)**

Source: Queensland Herbarium (2018)

Known distribution

In Queensland the Slender darling pea can be found around Roma and possibly further west and near the NSW border. In NSW it has been recorded from just north of Moree southwest across to Mildura and the Victorian border (refer Figure 4.2). It has been recorded in northwestern Victoria as well as the southeastern corner of South Australia (OEH 2017). Refer Figure 4.2.

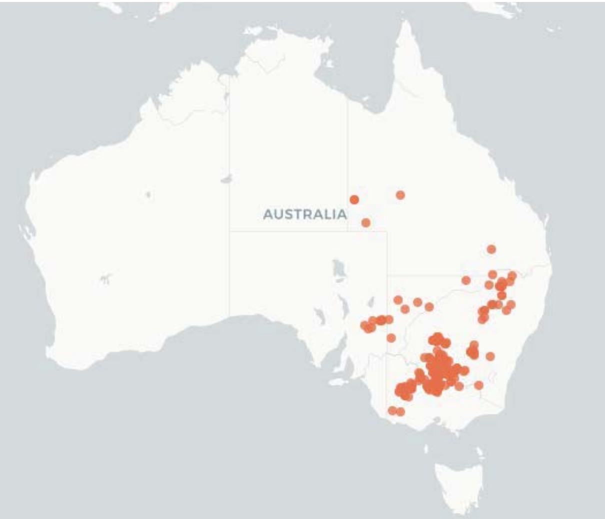


Figure 4.2 **Distribution range of the Slender darling pea**

Source: ALA (2019)

Biology and reproduction

Slender darling pea produces winter-spring growth, flowering in spring to early summer and then dying back after flowering. They re-shoot readily and often carpet the landscape after cool season rains. This species has been known to occur in paddocks that have been moderately grazed or occasionally cultivated. Swainsona species contain swainsonine, which affects the nervous system and is toxic to livestock (OEH 2017).

4.2.3 Habitat

The Slender darling pea has been collected from clay-based soils, ranging from grey, red and brown cracking clays to red-brown earths and loams. It grows in a variety of vegetation types including Bladder saltbush, Black box and grassland communities on level plains, floodplains and depressions and is often found with *Maireana* species. Plants have been found in remnant native grasslands or grassy woodlands that have been intermittently grazed or cultivated (OEH 2017).

4.2.4 Threatening processes

The following have been identified as potentially threatening processes to Slender darling pea:

- Heavy grazing by domestic stock and pest species
- Loss of grassland habitat to cultivation
- Invasion of grassland habitat by weeds
- Increased salinisation
- Frequent fires may directly affect plants or alter the habitat in which it grows
- Urban developments and the expansion of townships (OEH 2017).

4.2.5 Species resilience

Determination of species resilience is presented in Table 4.2.

4.2.6 References

Atlas of Living Australia (2019). *Swainsona murrayana*. Available from: https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2888731#overview [Accessed 13 September 2019].

Department of Sustainability and Environment, Victoria (2007). A Nationally Threatened Species of the Grassland Community. Slender Darling-pea (*Swainsona murrayana*). Victorian Government Department of Sustainability and Environment. Melbourne, Department of Sustainability and Environment. Available from: http://www.northernplainscmn.com.au/uploads/flora_fauna/fact_sheets/slender-darling-pea.pdf.

Harden, G.J. (ed.) (1991). *Flora of New South Wales, Volume Two*. Kensington, NSW: University of NSW Press.

Jeanes, J.A. (1996). Fabaceae. In: Walsh, N.G. & T.J. Entwisle, eds. *Flora of Victoria*. 3:663-829. Inkata Press, Melbourne.

Office of Environment and Heritage (2017). Slender darling pea - Profile. Available from: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10779 [Accessed 13 September 2019].

Table 4.2 **Species resilience questionnaire – Slender Darling-Pea *(Swainsona murrayana)***

Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes (2) ▪ Unlikely to change as a result of the projected changes (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Threatening processes to this species include: ▪ Heavy grazing by domestic stock and pest species ▪ Loss of grassland habitat to cultivation ▪ Invasion of grassland habitat by weeds ▪ Increased salinisation ▪ Frequent fires may directly affect plants or alter the habitat in which it grows ▪ Urban developments and the expansion of townships (OEH 2017). Vegetation clearing works within areas of species habitat are considered likely to contribute to threatening processes for the species via habitat clearance and fragmentation and increased predation vulnerability.	2
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ▪ Decline or shift from current location (3) ▪ Stay the same and in approximately the same location (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	This species is a grassland specialist and reproduces via seed set. No impacts to species reproductive ability is anticipated.	0
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ▪ Decline or shift from current location (2) ▪ Stay the same and in approximately the same location (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	The area or location of the associated vegetation type used for non-breeding activities by this species expected to stay the same and in approximately the same location	0

Item	Question	Criteria	Species response	Score
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Unlikely to change (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Breeding habitats are not expected to change as a result of the proposed activities	0
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ▪ Expected to decrease or habitat components required for non-breeding unknown (2) ▪ Unlikely to change (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Other specific habitat components required for survival during non-breeding periods are not expected to change within the associated vegetation type for this species	0
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	▪ Low ability to disperse (2) ▪ Mobile, but dispersal is sex-biased (only one sex disperses) (1) ▪ Very mobile, both sexes disperse (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	This species disperses via seed. Dispersal mechanisms are well developed in this species	0
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	▪ Species migratory habitats will be adversely affected (2) ▪ Species migratory habitats will not be adversely affected (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	The species does not migrate and as such there is unlikely to be any deviation from the current state	0

Item	Question	Criteria	Species response	Score
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ▪ Limited flexible strategies to cope with variable resources across multiple years (2) ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	During adverse conditions, this species may persist as a seed in the soil seed bank. Whilst growing plants are adaptable in relation to growing conditions, drought or earth-works are likely to result in the death of plants.	2
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ▪ Once per year or less (2) ▪ More than once per year (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	The species reproduces (via seed) during a single period.	2
Q10.	Food resources: Are important food resources for this species expected to change?	▪ Primary food source(s) are expected to be negatively impacted by projected changes (2) ▪ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	This species has the ability to produce its own food (photosensitise). No impacts are expected associated with food availability.	0
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: ▪ Is expected to increase as a result of the projected changes (2) ▪ Is not expected to be impacted by the projected changes (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Predation to this species (e.g. grazing) Is not expected to be impacted by the projected changes	0

Item	Question	Criteria	Species response	Score
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	- Disease prevalence is expected increase with projected changes (2) - No known effects of expected changes on disease prevalence (0) - Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	There are no known effects expected to this species in relation to disease or the prevalence of disease	0
Q13.	Competitors: Are populations of important competing species expected to change?	- Major competitor species are expected to be positively impacted by projected changes (2) - Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species (0) - Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Species has a variety of competitive relationships; however, disturbance may increase the number of competitive non-native grasses that have the ability to out-compete this species.	2
Total score				8
Species resilience				**Moderate**

Queensland Herbarium (2018). Slender Darling-pea (*Swainsona murrayana*). (Image) [Online] Available from: https://images.ala.org.au/image/details?imageId=49d0d1b9-bc50-4516-a3bc-3045a585e809. [20 September 2019].

Schmidt-Lebhun, A.N. (n.d.). *Swainsona murrayana* (Image) [Online] Available from: https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2888731#gallery [Accessed 13 September 2019].

4.3 *Dichanthium setosum* – (Bluegrass)

4.3.1 Status

EPBC Act – Vulnerable

BC Act – Vulnerable

4.3.2 Biology and ecology

Characteristics

Bluegrass (*Dichanthium setosum*) is an upright perennial grass less than 1 m tall. It has mostly hairless leaves about 2 to 3 mm wide. The flowers are densely hairy and clustered together along a stalk in a cylinder shape (refer Photograph 4.3) and appear mostly during summer. The species can form pure swards or occur as scattered clumps (Ayers et al. 1996; DEC 2005 as in DEWHA 2008; Harden 1993).

Photograph 4.3 Bluegrass (*Dichanthium setosum*)

Source: Rose (2013)

Known distribution

Bluegrass occurs on the northern tablelands in the Saumarez area, west of Armidale, and 18 to 30 km east of Guyra. It has been found sparsely on the northwestern slopes, central western slopes and northwestern plains of NSW, extending west to Narrabri. In Queensland, it has been documented to occur from the Leichhardt, Morton, North Kennedy and Port Curtis regions (refer Figure 4.3). This species occurs in the Mistake Range, in Main Range National Park, and possibly in Glen Rock Regional Park, adjacent to the Main Range National Park (Ayers et al. 199; Henderson 1997).

Figure 4.3 **Distribution range of Bluegrass**

Source: ALA (2019)

Biology and reproduction

Bluegrass is a warm season perennial grass, that commences growing in springs, flowers in summer and becomes dormant in late autumn. A fire frequency of greater than five years has been recommended for the species (NSW OEH 2013; Yu et al. 2000).

4.3.3 Habitat

Bluegrass is associated with heavy basaltic black soils and stony red-brown hardsetting loam with clay subsoil and is found in moderately disturbed areas such as cleared woodland, grassy roadside remnants, grazed land and highly disturbed pasture. The extent to which this species tolerates disturbance is unknown. The species occurs within the Border Rivers−Gwydir, Central West, Namoi, Northern Rivers (NSW), South East and Fitzroy (Queensland) Natural Resources Management regions (Ayers et al. 1996; DEC 2005).

4.3.4 Threatening processes

The following have been identified as potentially threatening processes to Bluegrass:

- Heavy grazing by agricultural animals
- Clearing of habitat for pasture and cropping
- Frequent irregular fires for agricultural purposes
- Road widening
- Invasion by introduced grasses (NSW OEH 2013).

4.3.5 Species resilience

Determination of species resilience is presented in Table 4.3.

Table 4.3 Species resilience questionnaire – Bluegrass (*Dichanthium setosum*)

Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes (2) ▪ Unlikely to change as a result of the projected changes (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Threatening processes to this species include: ▪ Heavy grazing by agricultural animals ▪ Clearing of habitat for pasture and cropping ▪ Frequent irregular fires for agricultural purposes ▪ Road widening ▪ Invasion by introduced grasses Vegetation clearing works within areas of species habitat are considered likely to contribute to threatening processes for the species via habitat clearance and fragmentation and increased predation vulnerability.	2
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ▪ Decline or shift from current location (3) ▪ Stay the same and in approximately the same location (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	This species is a grassland specialist and reproduces via seed set. No impacts to species reproductive ability is anticipated.	0
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ▪ Decline or shift from current location (2) ▪ Stay the same and in approximately the same location (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	The area or location of the associated vegetation type used for non-breeding activities by this species expected to stay the same and in approximately the same location	0
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Unlikely to change (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Breeding habitats are not expected to change as a result of the proposed activities	0

Item	Question	Criteria	Species response	Score
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ▪ Expected to decrease or habitat components required for non-breeding unknown (2) ▪ Unlikely to change (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Other specific habitat components required for survival during non-breeding periods are not expected to change within the associated vegetation type for this species	0
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	▪ Low ability to disperse (2) ▪ Mobile, but dispersal is sex-biased (only one sex disperses) (1) ▪ Very mobile, both sexes disperse (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	This species disperses via wind-borne seed. Dispersal mechanisms are well developed in this species	0
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	▪ Species migratory habitats will be adversely affected (2) ▪ Species migratory habitats will not be adversely affected (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	The species does not migrate and as such there is unlikely to be any deviation from the current state	0
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ▪ Limited flexible strategies to cope with variable resources across multiple years (2) ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	During adverse conditions, this species may persist as a seed in the soil seed bank. Whilst growing plants are adaptable in relation to growing conditions, drought or earth-works are likely to result in the death of plants. The species is an annual so any impacts to seed set will impact significantly upon this species.	2
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ▪ Once per year or less (2) ▪ More than once per year (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	The species reproduces (via seed) during a single period.	2

Item	Question	Criteria	Species response	Score
Q10.	Food resources: Are important food resources for this species expected to change?	▪ Primary food source(s) are expected to be negatively impacted by projected changes (2) ▪ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	This species has the ability to produce its own food (photosensitise). No impacts are expected associated with food availability.	0
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: ▪ Is expected to increase as a result of the projected changes (2) ▪ Is not expected to be impacted by the projected changes (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Predation to this species (e.g. grazing) Is not expected to be impacted by the projected changes	0
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	▪ Disease prevalence is expected increase with projected changes (2) ▪ No known effects of expected changes on disease prevalence (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	There are no known effects expected to this species in relation to disease or the prevalence of disease	0
Q13.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes (2) ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Species has a variety of competitive relationships; however, disturbance may increase the number of competitive non-native grasses that have the ability to out-compete this species.	2
Total score				8
Species resilience				**Moderate**

4.3.6 References

Atlas of Living Australia (2019). Distribution of *Dichanthium setosum,* viewed 13 September 2019, available: https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2905357.

AusGrass2 (2019). *Dichanthium setosum,* viewed 13 September 2019, available: http://ausgrass2.myspecies.info/content/dichanthium-setosum.

Ayers, D, Nash, S, and Baggett, K (Eds) (1996), Threatened Species of Western New South Wales, New South Wales National Parks and Wildlife Service, Hurstville.

Department of the Environment, Water, Heritage and the Arts (2008). Approved Conservation Advice for *Dichanthium setosum*. Canberra: Department of the Environment, Water, Heritage and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/14159-conservation-advice.pdf. In effect under the EPBC Act from 26 March 2008.

Harden, GJ (Ed) 1993, Flora of New South Wales, Volume Four, University of New South Wales Press,

Kensington. Henderson, RJF (1997), Queensland Plants Names and Distribution, Queensland Herbarium: Indooroopilly.

NSW Office of Environment and Heritage (2019), *Dichanthium setosum* – Profile, viewed 13 September 2019,at: **https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10221**Rose, H. (2013). *Dichanthium setosum*. [image] [online] Available at: **https://www.flickr.com/photos/73840284@N04/8675273472**. [13 September 2019].

Yu, P., N. Prakash and R.D.B. Whalley (2000). Comparative reproductive biology of the vulnerable and common grasses in Bothriochloa and Dicanthium. In: Jacobs, S.W.L. and J. Everett, eds. Grasses: systematics and evolution. CSIRO Publishing, Collingwood.

4.4 *Homopholis belsonii* – (Belson's panic)

4.4.1 Status

EPBC Act – Vulnerable

BC Act – Endangered

4.4.2 Biology and ecology

Characteristics

Belson's panic (*Homopholis belsonii*) is a perennial grass capable of growing up to 0.5 m high, with leaf ligule at 0.8 to 1.5 mm and long leaf blades spanning between 2 to 4.5 mm in width (refer Photograph 4.4). The leaves of the plant are often glabrous however can also be found with ciliates at the base (TSSC 2008; OEH 2017).

Along the lowermost branch two to three laterally compressed 4.8 to 8 mm spikelet feature whilst the common axis of the inflorescence and the primary branches both reach a length of 8 to 15 cm. The primary branches however contain hairy axils (OEH 2017).

Photograph 4.4 Belson's panic (*Homopholis belsonii*)

Source: Queensland Herbarium (2018)

Known distribution

Belson's panic is known to occur along the northwest slopes and plains of NSW, between Wee Waa, Goondwindi and Glen Innes, and in Queensland along the southern Brigalow Belt near the Darling Downs area west of Toowoomba, Oakey and Millmerran. In Queensland, Belson's panic has been identified to cover an area of over 80,000 km^2 (DotEE 2019, OEH 2019) (refer Figure 4.4).

Figure 4.4 Distribution range of Belson's panic

Source: ALA (2019)

Biology and reproduction

Belson's panic is known to occur in isolated areas of remnant vegetation with an ability to recolonise cleared or highly disturbed environments. The species is often found in regenerating vegetation along roadsides in sufficiently large populations producing seeds, despite viability time not known (DotEE 2019).

Flowering of the species usually occurs between February to May and possibly in November to December as fruiting has been recorded in February. Belson's panic has indicated the ability to germinate readily without the need for a dormancy period and dispersal through wind occurs when panicles dry after seed formation (DotEE 2019).

4.4.3 Habitat

Belson's panic has been known to grow often in poor soils in dry woodlands especially in NSW as well as in areas which receive irregular or intermittent flooding, where Belson's panic can be found on higher, well-drained rises. An elevation level of 200 to 520 m is required for the species in NSW whilst in Queensland, the species range from 342 to 500 m elevation (DotEE 2019).

The species can be classified to grow in three specific habitats which include:

- Rocky and basaltic hills featuring White Box (*E. albens*) and Wilga (*G. parviflora*) woodlands with various shrub and grass species
- Flat to gently undulating alluvial areas featuring Belah (*Casuarina cristata*) forests and occasionally Brigalow (*Acacia harpophylla*) forests
- Drainage lines featuring Belah and sandy country dominated by Cypress Pine-Bloodwood-Ironbark-She-Oak Forest (TSSC 2008).

4.4.4 Threatening processes

The following have been identified as potentially threatening processes to Belson's panic:

- Habitat clearing for agriculture, development and/or pasture improvement
- Overgrazing by domestic stock
- Invasion of habitat by introduced species
- Encroachment of native vegetation impacting survival and reproduction in locations (OEH 2017).

4.4.5 Species resilience

Determination of species resilience is presented in Table 4.4.

4.4.6 References

Atlas of Living Australia (1998). Homopholis belsonii. Available from: https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2912755#overview [Accessed 17 September 2019].

Department of the Environment (2019). Homopholis belsonii in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. [Accessed 17 September 2019].

Office of Environment and Heritage (2019). Belson's Panic – profile. New South Wales Government. Available from: https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10925 [Accessed 18 September 2019].

Queensland Herbarium. (2018). *Belson's panic (Homopholis belsonii)*. [Image] [Online] Available from: https://images.ala.org.au/image/details?imageId=b5335e13-c937-4b4c-a7c0-5e725c5ee083. [19 September 2019].

Threatened Species Scientific Committee (2008). Commonwealth Conservation Advice on Homopholis belsonii. Available from http://www.environment.gov.au/biodiversity/threatened/species/pubs/2406-conservation-advice.pdf [Accessed 18 September 2019].

Table 4.4 **Species resilience questionnaire – Belson's panic (*Homopholis belsonii*)**

Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ■ Increase in intensity as a result of the projected changes (2) ■ Unlikely to change as a result of the projected changes (0) ■ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Threatening processes to this species include: ■ Habitat clearing for agriculture, development and/or pasture improvement ■ Overgrazing by domestic stock ■ Invasion of habitat by introduced species ■ Encroachment of native vegetation impacting survival and reproduction in locations Vegetation clearing works within areas of species habitat are considered likely to contribute to threatening processes for the species via habitat clearance and fragmentation and increased predation vulnerability.	2
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ■ Decline or shift from current location (3) ■ Stay the same and in approximately the same location (0) ■ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	This species and reproduces via seed set. No impacts to species reproductive ability is anticipated.	0
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ■ Decline or shift from current location (2) ■ Stay the same and in approximately the same location (0) ■ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	The area or location of the associated vegetation type used for non-breeding activities by this species expected to be reduced in size by the project activities	2
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ■ Expected to decrease or habitat components required for breeding unknown (3) ■ Expected to decrease or habitat components required for breeding unknown (3) ■ Unlikely to change (0) ■ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Breeding habitats are not expected to change as a result of the proposed activities	0

Item	Question	Criteria	Species response	Score
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ▪ Expected to decrease or habitat components required for non-breeding unknown (2) ▪ Unlikely to change (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Other specific habitat components required for survival during non-breeding periods are not expected to change within the associated vegetation type for this species	0
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	▪ Low ability to disperse (2) ▪ Mobile, but dispersal is sex-biased (only one sex disperses) (1) ▪ Very mobile, both sexes disperse (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	This species disperses via wind-borne seed. Dispersal mechanisms are well developed in this species	0
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	▪ Species migratory habitats will be adversely affected (2) ▪ Species migratory habitats will not be adversely affected (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	The species does not migrate and as such there is unlikely to be any deviation from the current state	0
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ▪ Limited flexible strategies to cope with variable resources across multiple years (2) ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	During adverse conditions, this species may persist as a seed in the soil seed bank. Whilst growing plants are adaptable in relation to growing conditions, drought or earth-works are likely to result in the death of plants. The species is an annual so any impacts to seed set will impact significantly upon this species.	2
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ▪ Once per year or less (2) ▪ More than once per year (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	The species reproduces (via seed) during a single period	2

Item	Question	Criteria	Species response	Score
Q10.	Food resources: Are important food resources for this species expected to change?	▪ Primary food source(s) are expected to be negatively impacted by projected changes (2) ▪ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	This species has the ability to produce its own food (photosensitise). No impacts are expected associated with food availability.	0
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: ▪ Is expected to increase as a result of the projected changes (2) ▪ Is not expected to be impacted by the projected changes (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Predation to this species Is not expected to be impacted by the projected changes	0
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	▪ Disease prevalence is expected increase with projected changes (2) ▪ No known effects of expected changes on disease prevalence (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	There are no known effects expected to this species in relation to disease or the prevalence of disease	0
Q13.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes (2) ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Species has a variety of competitive relationships; however, disturbance may increase the number of competitive non-native grasses that have the ability to out-compete this species.	2
Total score				10
Species resilience				**Moderate**

4.5 Cadellia pentastylis - (Ooline)

4.5.1 Status

EPBC Act – Vulnerable

BC Act – Vulnerable

4.5.2 Biology and ecology

Characteristics

Ooline is a medium-sized spreading tree usually about 10 m tall, and rarely to 25 m. It is very slow-growing. The glossy green leaves are 2 to 4 cm long and 15 to 20 mm wide, with broadly rounded tips. The upper sides of the leaves are darker and glossier than the undersides. Leaf venation is prominent on both leaf surfaces when dry. The white flowers are small and usually single. Each flower produces a cluster of up to five rounded, brown berries, 3 to 5 mm wide. Cadellia pentastylis is of considerable biogeographic interest as it is a relic of an extensive rainforest vegetation that covered much of Australia in the past. The species appears to flower spasmodically, during a general flowering period of October to January. Dispersal of fruit and seed is probably by “passive fall” or by birds. Seeds showed a high rate of infertility at all sites, although they have been successfully germinated and established after heat application. The species has the capacity to resprout from rootstock and coppice vigorously from stumps, a feature which may be critical for the species survival in a fire-prone environment (OEH 2019).

Photograph 4.5 **Ooline**

Source: McMaster (2008)

Known distribution

Ooline occurs on the western edge of the NSW north-west slopes, from Mt Black Jack near Gunnadah to west of Tenterfield, and extends into Queensland to Carnarvon Range and Callide Valley, south-west of Rockhampton (Harden et al. 2006). This species is conserved within the Tregole National Park (NP), Sundown NP, Carnarvon Gorge NP, Mt Kaputar NP, Gamilaroi Nature Reserve (NR), Gibraltar NR, Bunal Flora Reserve (FR), Mehi FR, Campbell State Forest (SF) and Deriah SF (Briggs & Leigh 1996; Curran & Curran 2005). Both Sundown NP and Carnarvon Gorge NP have more than 1,000 individuals (Briggs & Leigh 1996). Some existing stands are on private property (Fletcher 2002). This species occurs within the Border River–Gwydir, Namoi (NSW), Burdekin, Burnett Mary and South West Queensland Natural Resource Management Regions. The natural range of Ooline is from 24ºS to 30ºS in the 500 to 750 mm per annum rainfall belt. (DotEE 2019, OEH 2019)

Figure 4.5 **Distribution range of Ooline**

Source: ALA (2019)

4.5.3 Habitat

Ooline grows in dry rainforest, semi-evergreen vine thickets and sclerophyll ecological communities, often locally dominant or as an emergent. Plants have been reported to be growing in cultivation at the Australian National Botanic Gardens, Canberra and Royal Botanic Gardens, Sydney (CHABG 1994).

The distribution of this species overlaps with the following EPBC Act-listed threatened ecological communities:

- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions
- Brigalow (Acacia harpophylla dominant and co-dominant)
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland.

There appears to be a strong correlation between the presence of Ooline and low- to medium-nutrient soils of sandy clay or clayey consistencies, with a typical soil profile having a sandy loam surface layer, grading from a light clay to a medium clay with depth (OEH 2019).

4.5.4 Threatening processes

The main threats listed for the species are:

- Localised extinction due to small scattered populations
- Inbreeding which threatens genetic diversity
- Low seed viability

- Logging
- Clearing for agriculture
- Grazing and soil compaction by domestic stock, feral goats and pigs
- Invasion of habitat by weeds
- Frequent fires
- Tunnel and sheet erosions
- Damage to roadside populations during roadworks
- High insect attacks.

4.5.5 Species resilience

Determination of species resilience shown in Table 4.5.

4.5.6 References

Atlas of Living Australia. (2019). Cadellia pentastylis – Available online at: https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2912802 [Viewed 18 September 2019]

Department of the Environment and Energy – Species Profile and Threats Database – Cadellia pentastylis – Ooline viewed online at: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=9828 [Viewed 18 September 2109]

Eddie,C. 2012. *SANTOS Field Guide to the Trees and Shrubs of Eastern Queensland Oil and Gas Fields*. Finsbury Green Printing

McMaster, I. (2008). *Cadellia pentastylis*. [image] [online] Available from: https://bie.ala.org.au/species/http://id.biodiversity.org.au/node/apni/2912802# [28 August 2018].

Office of Environment and Heritage – Threatened Species Profiles – Ooline (Cadellia pentastylis) Available online at: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10118 [Viewed 18 September 2109]

Table 4.5 **Species resilience questionnaire – Ooline (*Cadellia pentastylis*)**

Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes (2) ▪ Unlikely to change as a result of the projected changes (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Threatening processes to this species include: ▪ Habitat clearing for agriculture, development and/or pasture improvement ▪ Overgrazing by domestic stock ▪ Invasion of habitat by introduced species ▪ Encroachment of native vegetation impacting survival and reproduction in locations Vegetation clearing works within areas of species habitat are considered likely to contribute to threatening processes for the species via habitat clearance and fragmentation and increased predation vulnerability.	2
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ▪ Decline or shift from current location (3) ▪ Stay the same and in approximately the same location (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	This species reproduces via seed set. No impacts to species reproductive ability is anticipated.	0
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ▪ Decline or shift from current location (2) ▪ Stay the same and in approximately the same location (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	The area or location of the associated vegetation type used for non-breeding activities by this species expected to be reduced in size by the project activities	2
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Unlikely to change (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Breeding habitats are not expected to change as a result of the proposed activities	0

Item	Question	Criteria	Species response	Score
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ▪ Expected to decrease or habitat components required for non-breeding unknown (2) ▪ Unlikely to change (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Other specific habitat components required for survival during non-breeding periods are not expected to change within the associated vegetation type for this species	0
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	▪ Low ability to disperse (2) ▪ Mobile, but dispersal is sex-biased (only one sex disperses) (1) ▪ Very mobile, both sexes disperse (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	This species disperses via wind-borne seed. Dispersal mechanisms are well developed in this species	0
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	▪ Species migratory habitats will be adversely affected (2) ▪ Species migratory habitats will not be adversely affected (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	The species does not migrate and as such there is unlikely to be any deviation from the current state	0
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ▪ Limited flexible strategies to cope with variable resources across multiple years (2) ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	During adverse conditions, this species may persist as a seed in the soil seed bank. Whilst growing plants are adaptable in relation to growing conditions, drought or earth-works are likely to result in the death of plants. The species is an annual so any impacts to seed set will impact significantly upon this species.	2
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ▪ Once per year or less (2) ▪ More than once per year (0) ▪ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	The species reproduces (via seed) during a single period	2

Item	Question	Criteria	Species response	Score
Q10.	Food resources: Are important food resources for this species expected to change?	■ Primary food source(s) are expected to be negatively impacted by projected changes (2) ■ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes (0) ■ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	This species has the ability to produce its own food (photosensitise). No impacts are expected associated with food availability.	0
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: ■ Is expected to increase as a result of the projected changes (2) ■ Is not expected to be impacted by the projected changes (0) ■ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Predation to this species Is not expected to be impacted by the projected changes	0
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	■ Disease prevalence is expected increase with projected changes (2) ■ No known effects of expected changes on disease prevalence (0) ■ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	There are no known effects expected to this species in relation to disease or the prevalence of disease	0
Q13.	Competitors: Are populations of important competing species expected to change?	■ Major competitor species are expected to be positively impacted by projected changes (2) ■ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species (0) ■ Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species (120)	Species has a variety of competitive relationships; however, disturbance may increase the number of competitive non-native grasses that have the ability to out-compete this species.	2
Total score				10
Species resilience				**Moderate**

5 Critically endangered fauna species

5.1 Curlew sandpiper (*Calidris ferruginea*)

5.1.1 Status

EPBC Act – Critically Endangered Marine and Migratory (CAMBA)

BC Act – Endangered

5.1.2 Biology and ecology

Characteristics

The Curlew sandpiper (*Calidris ferruginea*) is a small sandpiper approximately 18 to 23 cm long with a wingspan of 38 to 41 cm and weighing about 57 g. The head is small and round with a black bill that is long and decurved with a slender tip, sometimes with a brown or green tinge at the base (refer Photograph 5.1). The sexes are similar, but females have a slightly larger and longer bill and a slightly paler underbelly in breeding plumage (Higgins and Davies 1996).

In breeding plumage, the head, neck and underbody are a rich chestnut-red with narrow black bars on the belly and flanks. There are black streaks on the crown, a dusky loral stripe, and white around the base of the bill. The feathers on the mantle and scapulars are black with large chestnut spots and grayish-white tips. The back and upper rump are dark brown, with a prominent square white patch across the lower rump and uppertail-covert (Higgins and Davies 1996).

During the breeding season the cap, ear-coverts, hindneck and sides of neck are pale brownish-grey with fine dark streaks changing to white on the lower face and throat. There is a narrow dark loral stripe and white supercilium from the bill to above the rear ear-coverts. The mantle, back, scapulars, tertials and innerwing-coverts are pale brownish-grey with fine dark streaks. The underbody is white with a brownish-grey wash and fine dark streaks on the breast (Higgins and Davies 1996).

Photograph 5.1 Curlew sandpiper (Calidris ferruginea)

Source: Emilio (2014)

Known distribution

In Australia, Curlew sandpipers occur around the coasts and are also quite widespread inland (refer Figure 5.1). Records occur in all states and territories during the non-breeding season as well as the breeding season when immature birds remain in Australia rather than migrating north towards Siberia (DotEE 2019).

In Queensland, widespread records occur along the coast south of Cairns with sparsely scattered records inland. In NSW, they are widespread east of the Great Divide, especially in coastal regions. They are occasionally recorded in the Tablelands and are widespread in the Riverina and southwest NSW, with scattered records elsewhere (Higgins and Davies 1996).

Figure 5.1 Distribution range of the Curlew sandpiper

Source: ALA (2019)

Biology and reproduction

In Australia, the Curlew sandpiper forages mainly on invertebrates, including worms, molluscs, crustaceans, and insects, as well as seeds. Curlew sandpipers usually forage by pecking and probing in water, near the shore or on bare wet mud at the edge of wetlands. They glean from mud, from the surface of water, or in drier areas above the edge of the water. Curlew sandpipers may wade up to the belly, often with their heads submerged while probing. They often forage in mixed flocks, including with Red-necked stints (*Calidris ruficollis*). In tidal waters, the birds move onto the most recently exposed parts of the tidal flats and retreat in stages as the tide comes in. Supratidal feeding mainly occurs during the pre-migratory fattening periods (February to April) (Dann 1999a; Dann 1999b).

This species does not breed in Australia and they move north to Siberia to breed and nest during June and July (Hayman et al. 1986).

Habitat

Curlew sandpipers mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. They have also been recorded inland around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand. They occur in both fresh and brackish waters. Occasionally they are recorded around floodwaters and wet mats of algae or waterweed, or on banks of beachcast seagrass or seaweed (Higgins and Davies 1996).

Curlew sandpipers generally roost on bare dry shingle, shell or sand beaches, sandspits and islets around coastal and near-coastal lagoons and other wetlands. They occasionally roost in dunes and saltmarshes (Higgins and Davies 1996).

5.1.3 Threatening processes

The following have been identified as potentially threatening processes to the Curlew sandpiper:

- In non-breeding grounds in Australia, this species mostly occurs in highly populated areas and is therefore vulnerable to possible habitat alteration
- Threats to the Curlew sandpiper include the loss and fragmentation of feeding and roosting habitat from human development, human disturbance at roost and feeding sites, disturbance by wild dogs and pollution (DECC 2005; Gosbell et al. 2002; Lane 1987).

5.1.4 Species resilience

Determination of species resilience is presented in Table 5.1.

5.1.5 References

Atlas of Living Australia (2019). *Calidris (Erolia) ferruginea*. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:fa188c0e-68ba-4b3f-8e8f-48734608c7d1 [Accessed 13 September 2019].

Dann, P. (1999a). Feeding periods and supratidal feeding of Red-necked Stints and Curlew Sandpipers in Western Port, Victoria. *Emu*. 99:218-222.

Dann, P. (1999b). Foraging behaviour and diets of Red-necked Stints and Curlew Sandpipers in southeastern Australia. *Wildlife Research*. 27:61-68.

Department of the Environment and Energy (2019). *Calidris ferruginea* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=856 [Accessed 13 September 2019].

Emilio, J. (2014). Curlew sandpiper (Calidris ferruginea). [image] [online] Available from: https://www.flickr.com/photos/juan_e/14189744097/in/photolist-3Dg6vj-XhMbXb-rEiyqF-XnhsNC-rssdoW-AUdiMa-pdsrhP-dhR1NF-XPhgeP-MPQ8zZ-q6ScfT-3fHmMC-PrPzBY-c2Wp1A-qadmL4-dMuRJe-MPQ8s4-224r7hp-YNVDc5-rA499X-dMuRA8-d9oHrS-J5pVor-Dnv4mM-nBU9yi-4nUe3Y-3ZKHWu-rA9TAR-fUJf3r-DAhXUZ-3ZFvdM-21Wxs4h-CCLU2s-Ds1PXx-D2MNA2-6eZssG-4FMQa8-DnvAzZ-6eVizr-vYK8Ps-J5q4k8-2327Qcz-21Fxk46. [18 September 2019].

Gosbell, K, Collins P. and Christie M. (2002). *Wader Surveys in the Coorong and S.E. Coastal Lakes February 2002*. Australasian Wader Studies Group.

Hayman, P., Marchant J. and Prater T. (1986). *Shorebirds. An identification guide to the waders of the world*. London and Sydney: Croom Helm.

Higgins, P.J. and Davies S.J.J.F. eds (1996). *Handbook of Australian, New Zealand and Antarctic Birds. Volume Three - Snipe to Pigeons*. Melbourne, Victoria: Oxford University Press.

Lane, B.A. (1987). *Shorebirds in Australia*. Sydney, NSW: Reed.

New South Wales National Parks and Wildlife Service (1999). *Threatened Species Information - Painted Snipe.*

Table 5.1 Species resilience questionnaire – Curlew sandpiper (*Calidris ferruginea*)

Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ■ Increase in intensity as a result of the projected changes **(2)** ■ Unlikely to change as a result of the projected changes **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have a adverse impact on the species* ***(120)***	Key threats to this species includes habitat loss and degradation. Other threatening processes include: ■ Disturbance from anthropogenic activities including recreation, fishing and aquaculture ■ Pollution with subsequent euthrophication ■ Predation by introduced species Due to the migratory nature of the species works will not disturb breeding activities, the Project works are not expected to disturb or reduce the quantity of breeding habitat for the species. Furthermore, the species do not appear to be restricted to highly specialised environments to facilitate non-breeding activities and as such the project works are not anticipated to significantly impact on habitat for the species. The nature of project works is not considered to have a significant contribution to the aforementioned threatening processes for the species.	0
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ■ Decline or shift from current location (3) ■ Stay the same and in approximately the same location **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species* ***(120)***	This species does not breed within Australia. The species does not appear to be restricted to highly specialised environments to facilitate breeding activities. As such Project works are not considered likely to reduce the area of breeding habitat available for the species.	0
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ■ Decline or shift from current location **(2)** ■ Stay the same and in approximately the same location **(0)** ■ *Due to species sensitivities', any impact on this value is expected to have an adverse impact on the species* ***(120)***	This species forages in a variety of tidal, intertidal and non-tidal environments including estuaries, bays, inlets and lagoons, mudflats, sandflats, swamps, lakes, lagoons and ponds in saltworks and sewage farms. The species have been recorded foraging in in natural and modified environments. Thus the species does not appear to be restricted to highly specialised environments to facilitate non-breeding activities. Project works are not considered likely to reduce the area of non-breeding habitat available for the species.	0

Item	Question	Criteria	Species response	Score
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ■ Expected to decrease or habitat components required for breeding unknown (3) ■ Expected to decrease or habitat components required for breeding unknown (3) ■ Unlikely to change **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species does not breed in Australia. This species is not considered reliant on specialised habitat components to facilitate breeding and as such Project works are not expected to significantly impact any breeding habitat resources for the species.	0
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ■ Expected to decrease or habitat components required for non-breeding unknown **(2)** ■ Unlikely to change **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The species does not appear to require any specific, specialised habitat components to facilitate non-breeding activities. Subsequently, Project works are not expected to significantly impact reduce the quantity of non-breeding habitat resources for the species.	0
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	■ Low ability to disperse **(2)** ■ Mobile, but dispersal is sex-biased (only one sex disperses) **(1)** ■ Very mobile, both sexes disperse **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The species is very mobile with a high ability to disperse as evident by its migratory nature	0
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	■ Species migratory habitats will be adversely affected **(2)** ■ Species migratory habitats will not be adversely affected **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The Project works will not create a barrier to species movement or separate vital habitats	0

Item	Question	Criteria	Species response	Score
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(2)** ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species* ***(120)***	Studies on the behaviour of migratory marine birds have found many shorebird species to compensate for habitat deterioration in one area by using other areas more heavily or returning when the disturbance declines, for example by foraging at night. The species transit nature allows it to easily disperse to cope with resource fluctuations. Migratory marine species are considered to have the appropriate flexible strategies to cope with resource fluctuations.	0
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ▪ Once per year or less **(2)** ▪ More than once per year **(0)** ▪ *Due to species sensitivities', any impact on this value is expected to have an adverse impact on the species* ***(120)***	This species does not breed within Australia	0
Q10.	Food resources: Are important food resources for this species expected to change?	▪ Primary food source(s) are expected to be negatively impacted by projected changes **(2)** ▪ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species* ***(120)***	This species is omnivorous, consuming plant as well as animal material. As the species do not have highly specialised dietary requirements and the primary food resource is abundant, Project works not anticipated to impact on the species primary food source.	0
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: ▪ Is expected to increase as a result of the projected changes **(2)** ▪ Is not expected to be impacted by the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species* ***(120)***	This species is vulnerable to predation by introduced species including Wild dogs (*Canis familiaris*), Feral cats (*Felis catus*) and Dingoes (*Canis familiaris*) Project works are unlikely to result in the spread of invasive species. With consideration to the highly mobile nature of the species and that the species are not restricted to specialised habitat components, the project works are not considered likely to increase the predation vulnerability of the species.	0

Item	Question	Criteria	Species response	Score
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	▪ Disease prevalence is expected increase with projected changes **(2)** ▪ No known effects of expected changes on disease prevalence (0) ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The nature of works is unlikely to introduce disease that may cause species decline	0
Q13.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes **(2)** ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	There are no major competitors recognised as a key threating process to the migratory marine species subject to this assessment	0
Total score				0
Species resilience				**High**

5.2 Silver perch (*Bidyanus bidyanus*)

5.2.1 Status

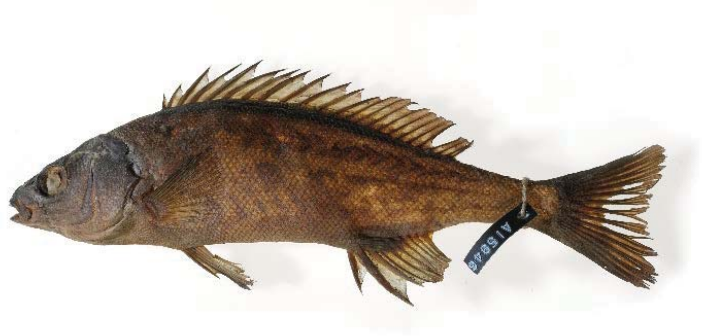
EPBC Act – Critically Endangered

BC Act – Vulnerable

5.2.2 Biology and ecology

Characteristics

A medium to large, fish with a body that becomes deeper and more laterally compressed with age. Maximum length ~500 mm and maximum weight 8 kg; usually 350 mm and 2 kg. The single dorsal fin has a higher, spinous anterior section and a lower, rayed section at the rear. They have a pointed head and snout and a relatively small mouth with equal jaws and narrow bands of very fine villiform (needle-like) teeth. The body colour is grey to grey-brown or dusky bronze with a lighter belly. The scales are much smaller than those on Golden or Macquarie perch. The tail is weakly forked. Very large specimens assume a slightly disproportionate appearance with a strongly humped forehead, strong lateral compression and a more distinctly pointed, almost beak-like head and snout. (Lintermans 2007, OEH 2019).



Photograph 5.2 Silver Perch (*Bidyanus bidyanus*)

Source: Michelle (2017)

Known distribution

Formerly widespread over much of the Murray-Darling Basin excluding the most upper reaches, Silver perch has declined over most of its range. Numbers moving through a fishway at Euston Weir on the Murray River declined by 93% between 1940 and 1990. Only nine Silver perch were recorded in a two-year survey of 40 randomly selected sites in the NSW portion of the Basin in the mid 1990s. The species is still patchily abundant in the mid-Murray. The ACT probably represented the upstream limit of distribution in the Murrumbidgee catchment, although the large spawning run of fish that occurred in summer from Lake Burrinjuck is unfortunately a thing of the past (Lintermands 2007,OEH 2019).

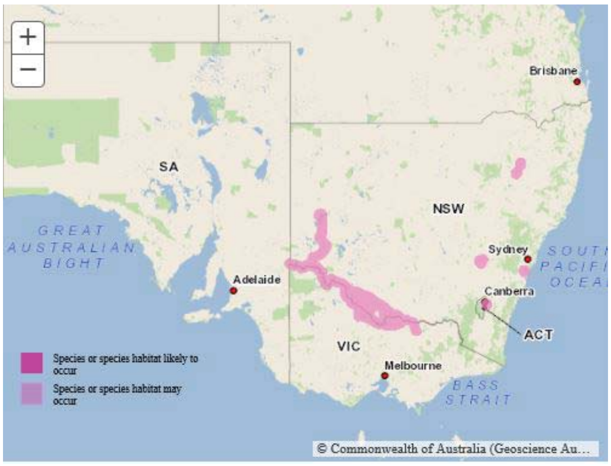


Figure 5.2 **Distribution range of Silver Perch**

Source: DotEE (2019)

Biology and reproduction

Silver perch display sexual dimorphism, with females growing to a larger size. Growth varies between individual fish and is affected by the productivity of environments. Male fish reach sexual maturity at three years of age, and female fish reach sexual maturity at four to five years of age. Growth slows dramatically in both sexes after sexual maturity. Mallen-Cooper and Stuart (2003) estimated a mean maximum size for Murray River silver perch of 422 mm for female fish and 377 mm for male fish. They spawn in spring and summer after an upstream migration, when large schools often form. Spawning occurs in late afternoon, dusk or just after nightfall. Spawning occurs in shoals at or near the surface, involves simultaneous release of milt (sperm) and eggs by male and female fish respectively, and is often accompanied by thrashing at the surface (Lake 1967a; Merrick and Schmida 1984; Clunie and Koehn 2001). Merrick and Schmida (1984) reported that spawning occurs where water flows over a gravel or rock rubble substrate. Whilst spawning can occur during nonflood conditions, spawning activity was significantly increased during a flood and environmental water release in 2005 in the mid-Murray River. Lake (1967b) found that fertilised, water-hardened eggs were 2.7 to 2.8 mm in diameter, and hatched in 30–31 hours at temperatures of 26 to 27°C. Silver perch eggs spawned at cooler temperatures had longer hatching times. Importantly, Lake (1967b) noted that silver perch eggs are semi-pelagic and will sink to the bottom in the absence of current; he also noted the propensity for the chorion (‘outer covering’) of silver perch eggs to adsorb very fine suspended sediment. The cumulative evidence indicates that silver perch reproduction is flexible in terms of flow conditions and temperature; reproduction can occur in both within-channel flows and floods and at relatively cool water temperatures. Surveys found that silver perch across the Murray-Darling Basin failed to recruit during 2008–2010 drought conditions and that its current low densities may heighten the risk from extended recruitment failure in the future (Davies et al. 2012).

Silver perch are omnivorous. The diet contains aquatic plants, snails, shrimps, zooplankton and aquatic insect larvae.

This species is bred artificially in a number of government and commercial hatcheries and widely stocked into farm dams and reservoirs. While significant numbers of silver perch are bred and grown in aquaculture facilities for human consumption in Australia and Asia, these aquacultured fish are not considered meaningful to the long-term survival of silver perch in the wild, as they are highly domesticated both in the behavioural and the genetic sense (Rowland 2009). Similarly, large numbers of hatchery-bred silver perch are stocked, usually in impoundments, but these stocked silver perch appear to make little improvement to the conservation situation of wild silver perch (Davies et al. 2008; Rowland 2009; Davies et al. 2012).

5.2.3 Habitat

Silver perch are found in similar habitats to Murray cod and Golden perch, i.e. lowland, turbid and slow-flowing rivers. However, numerous reliable accounts exist of silver perch penetrating to Cooma (approximately 800 m ASL) on the Murrumbidgee River in large-scale upstream migrations in summer in the early and mid 1900s. Silver perch are consistently reported by anglers and researchers to show a general preference for faster-flowing water, including rapids and races, and more open sections of river, throughout the Murray-Darling Basin (Clunie and Koehn 2001). In the upper Murrumbidgee River during the 1960s and 1970s, the species was renowned for migrating into clear fast-flowing rapids in summer, in which anglers observed and targeted them (Pratt 1979). Silver perch are a highly migratory freshwater fish. The extensive migration of adults, particularly during flooding, has long been recognised and is considered to be part of their spawning behaviour, likely a strategy to offset the downstream drift of eggs and larvae (Cadwallader 1977; Reynolds 1983; Mallen-Cooper et al. 1995). Reynolds (1983) tagged and then recovered a small number of tagged adult silver perch in the lower Murray River; most moved about 40 km upstream, while one fish moved 110 km and another 570 km upstream in 19 months.

5.2.4 Threatening processes

River regulation has severely affected this species through disruption of migration and reproductive behaviour. It is estimated there are 4000 barriers to fish movement in the Murray-Darling Basin in the form of dams, weirs and other structures (Lintermans 2007), the vast majority of which do not have fishways. Between 2001 and 2013, the Sea to Hume Dam Fish Passage Program provided purpose-built fishways to give native fish passage past 15 weirs and barrages on the Murray River between the river's mouth and Hume Dam at Albury (Lintermans, in prep. 2013), thereby ameliorating the impacts of weirs on the movement of juvenile and adult native fish, including silver perch in the middle and lower Murray River (but not necessarily native fish eggs and larvae).

Thermal pollution In the upper Murray system, large dams release cold water from their base, below the lower thermal limits for hatching and growth of native fish eggs and larvae, and disrupting cues for movement by juvenile and adult fish (e.g. Astles et al. 2003). Thermal pollution typically takes several hundred kilometres for water temperatures to be restored to normal (summarised in Clunie and Koehn 2001).

Blackwater events - Blackwater is water containing high levels of dissolved organic carbon which gives it a characteristic dark colour. Blackwater results from flood waters inundating floodplains or dry river channels, in the process leaching carbon compounds from inundated plant material. The dissolved organic carbon in blackwater encourages rapid bacterial growth which consumes dissolved oxygen and can reduce dissolved oxygen levels to very low levels that are fatal to fish and other aquatic organisms. While the extraction of dissolved organic carbon by floodwaters is a natural phenomenon, severe blackwater events are at least partially a result of river regulation, which has reduced the frequency and extent of floodplain inundation, and thus increased stores of dissolved organic carbon yielding plant material (Gerkhe et al. 1993; King et al. 2012).

Habitat degradation - It is widely recognised that Murray-Darling habitats have been degraded by desnagging, increased turbidity and salinity, loss of submergent macrophytes ('water weed'), and loss of riparian vegetation and associated siltation due to land clearing and a variety of poor farming practices including cattle grazing and trampling river banks (summarised in Clunie and Koehn 2001). While all of these forms of habitat degradation have affected silver perch, key impacts are likely to be (1) loss of submergent macrophytes, which may be important nursery areas for juvenile silver perch and important sites for feeding for all life stages, and (2) siltation, which can smother silver perch eggs that sink to the substratum in the absence of current.

Alien pathogens - There are many pathogens and parasites present in Murray-Darling waterways capable of affecting silver perch. Almost all are introduced ('alien'), having been brought into Australia with imports of live alien fish. Diverse evidence suggests alien pathogens and parasites may have had greater impacts on native fish species than realised in the past, and ongoing impacts in the present. The key alien pathogens and parasites are of concern are EHNV, Saprolegnia and Aphanomyces, Chilodonella, Ichthyophthirius, Lernaea and Asian fish tapeworm.

Interactions with alien species (Carp, Brown and Rainbow trout, *Gamubzia holbrooki* and Redfin perch) are also suspected to be a threat.

5.2.5 Species resilience

Determination of species resilience is presented in Table 5.2.

5.2.6 References

Astles KL, Winstanley RK, Harris JH and Gehrke PC (2003). Experimental study of the effects of cold water pollution on native fish. A final report for the Regulated Rivers and Fisheries Restoration Project. NSW Fisheries Final Report Series No. 44.

Cadwallader PL (ed.) (1977). J.O. Langtry's 1949–1950 Murray River Investigations. Fisheries and Wildlife Paper, Number 13. Fisheries and Wildlife Division, Ministry for Conservation, Melbourne.

Clunie P and Koehn J (2001). Silver Perch — A Resource Document. Volume 2. Murray Darling Basin Commission, Canberra. Available online at: http://www.dse.vic.gov.au/__data/assets/pdf_file/0019/112483/SilverPerchResourceDocument2001.pdf

Davies PE, Harris JH, Hillman TJ and Walker KF (2008). Sustainable Rivers Audit Report 1: A Report on the Ecological Health of Rivers in the Murray–Darling Basin 2004–2007. Prepared by the Independent Sustainable Rivers Audit Group for the Murray-Darling Basin Ministerial Council. Murray-Darling Basin Commission, Canberra.

Davies PE, Stewardson MJ, Hillman TJ, Roberts JR and Thoms MC (2012). Sustainable Rivers Audit Report 2: The ecological health of rivers in the Murray–Darling Basin at the end of the Millennium Drought, 2008–2010. Volume 1. Prepared by the Independent Sustainable Rivers Audit Group for the Murray-Darling Basin Ministerial Council. Murray-Darling Basin Commission, Canberra.

Department of the Environment (2019). *Bidyanus bidyanus* - Silver perch in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. Accessed Tue, 17 Sep 2019

Department of Environment .2013, Conservation Advice *Bidyanus bidyanus* (Silver perch) available online at: **http://www.environment.gov.au/biodiversity/threatened/species/pubs/76155-conservation-advice.pdf**

Department of Primary Industries 2019 Threatened species lists – Silver Perch Bidyanus bidyanus. Viewed online at: **https://www.dpi.nsw.gov.au/fishing/threatened-species/what-current/vulnerable-species/silver-perch**

Gehrke PC, Revel MB and Philbey AW (1993). Effects of river red gum, *Eucalyptus camaldulensis*, litter on Golden perch, *Macquaria ambigua.* Journal of Fish Biology 43: 265–279.

King AJ, Tonkin Z and Lieshcke J (2012). Short-term effects of a prolonged blackwater event on aquatic fauna in the Murray River, Australia: considerations for future events. Marine and Freshwater Research 63: 576–586.

Lintermands, M. 2007, *Fishes of the Murray Darling Basin: An introductory guide*. Murray Darling Basing Commission.

Table 5.2 **Species resilience questionnaire – Silver perch (*Bidyanus bidyanus*)**

Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ■ Increase in intensity as a result of the projected changes **(2)** ■ Unlikely to change as a result of the projected changes **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Key threats to this species include: ■ River regulations ■ Black water events ■ Habitat degradation ■ Alien pathogens ■ Alien fish Project works which require clearing are unlikely to increase threatening processes for this species	0
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ■ Decline or shift from current location (3) ■ Stay the same and in approximately the same location **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Area used for breeding habitat expected to: Stay the same and in approximately the same location	0
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ■ Decline or shift from current location **(2)** ■ Stay the same and in approximately the same location **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Area used for non-breeding habitat expected to Stay the same and in approximately the same location	0
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ■ Expected to decrease or habitat components required for breeding unknown (3) ■ Expected to decrease or habitat components required for breeding unknown (3) ■ Unlikely to change **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	No breeding habitat components will be changes as part of the project related activities	0

Item	Question	Criteria	Species response	Score
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ▪ Expected to decrease or habitat components required for non-breeding unknown **(2)** ▪ Unlikely to change **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Non-breeding habitat components will remain largely unchanged as a result of the project activities	0
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	Low ability to disperse **(2)** ▪ Mobile, but dispersal is sex-biased (only one sex disperses) **(1)** ▪ Very mobile, both sexes disperse **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This is aquatic and has a low ability to disperse	2
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	▪ Species migratory habitats will be adversely affected **(2)** ▪ Species migratory habitats will not be adversely affected **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Species migratory patterns are not likely to be altered in response to the project activities	0
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(2)** ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species is limited flexible strategies to cope with variable resource availability	2
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ▪ Once per year or less **(2)** ▪ More than once per year **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Only a brood single offspring is produced each year	2

Item	Question	Criteria	Species response	Score
Q10.	Food resources: Are important food resources for this species expected to change?	▪ Primary food source(s) are expected to be negatively impacted by projected changes **(2)** ▪ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species feeds on a variety of invertebrates and vertebrates. Important food resources are not expected to change as a result of the project.	0
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: ▪ Is expected to increase as a result of the projected changes **(2)** ▪ Is not expected to be impacted by the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Increased levels of predation and the species vulnerability is not expected to be impacted by the project activities	0
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	▪ Disease prevalence is expected increase with projected changes **(2)** ▪ No known effects of expected changes on disease prevalence (0) ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The nature of works is unlikely to introduce disease that may cause species decline	0
Q13.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes **(2)** ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	There are no major competitors recognised as a key threating process to this species. No change is expected.	0
Total score				6
Species resilience				**Moderate**

Mallen-Cooper M, Stuart IG, Hides-Pearson F and Harris J (1995) Fish migration in the Murray River and assessment of the Torrumbarry fishway. Final report for Natural Resource Management Strategy Project N002. NSW Fisheries Research Institute and the Cooperative Research Centre for Freshwater Ecology. Cited in: Clunie and Koehn (2001).

Merrick JR and Schmida GE (1984). Australian Freshwater Fishes — Biology and Management. Griffin Press Ltd. South Australia.

Michelle, M. (2017). Silver perch (*Bidyanus bidyanus*). [image] [online] Available from: https://images.ala.org.au/image/details?imageId=4d93d98a-ede5-4ad8-bd8e-40cc74a1c861. [19 September 2019].

Reynolds LF (1983). Migration patterns of five fish species in the Murray-Darling River system. Australian Journal of Marine and Freshwater Research 34: 857–871.

5.3 Swift parrot (*Lathamus discolor*)

5.3.1 Status

EPBC Act – Critically Endangered, Marine

BC Act – Endangered

5.3.2 Biology and ecology

Characteristics

The Swift parrot (*Lathamus discolor*) is a small lorikeet-like parrot with a long slender tail measuring approximately 25 cm in body length and weighing 77 g. The Swift parrot is predominately bright green in colour, with dark-blue patches on the crown, a prominent red face, and the chin and throat are narrowly bordered with yellow. One of most distinctive features from a distance is its long 12 cm, thin tail, which is dark red (refer Photograph 5.3). The female Swift parrot is distinguishable from the male as it has slightly duller feathering with a creamy underwing bar (Birdlife 2018; DES 2017; OEH 2017).

Photograph 5.3 Swift parrot (*Lathamus discolor*)

Source: eBird Australia (2015)

Known distribution

The Swift parrot is endemic to southeastern Australia. This species breeds only in Tasmania and migrates during the autumn and winter months to southeast Queensland as well as both coastal and the southwest slopes of NSW (DotEE 2019; OEH 2019) (refer Figure 5.3).

Figure 5.3 Distribution range of Swift parrot

Source: ALA (2019)

Biology and reproduction

The Swift parrot feeds mostly on nectar, mainly from Eucalypts, but also eats psyllid insects and lerps (waxy secretion on Eucalypt leaves produced as a protection by young psyllid insects), seeds and fruit. Swift parrots are mostly arboreal foragers, foraging mainly in Eucalypts, but occasionally coming to the ground to feed on seeds, fallen flowers, fruit and lerp, and to drink (DotEE 2019; Higgins 1999; Mallick et al. 2004; Swift parrot Recovery Team 2011).

Swift parrot's breeding season occurs from mid-September to late-January in Tasmania. Nests are typically constructed in hollows of trunks, a branch or spout of a living or dead gum tree with nests known to be used each year. The typical nesting season begins in late September with females laying 3 to 5 eggs during October and November. The females incubate the eggs and fledging hatch from early December to late January (Birdlife 2018; DotEE 2019; Higgins 1999; Swift parrot Recovery Team 2011).

5.3.3 Habitat

The Swift parrot typically inhabits dry sclerophyll, Eucalypt forests, woodlands, suburban parks and even gardens with flowering fruit trees with records showing It occasionally inhabiting wet sclerophyll forests (Birdlife 2019; Swift parrot Recovery Team 2011).

In northern NSW and southeastern Queensland, Narrow-leaved ironbark (*Eucalyptus crebra*), Forest red gum (*E. tereticornis*) forests and Yellow box (*E. melliodora*) forest are commonly utilised by Swift parrots (OEH 2017, Swift parrot Recovery Team 2011). While on the western slopes Mugga ironbark (*E. sideroxylon*) and Grey Box (*E. microcarpa*) woodlands are used (Saunders and Heinsohn 2008).

Habitats associated with the inland slopes of the Great Dividing Range, and along the eastern coastal plains, are considered the principal wintering grounds (Kennedy and Overs 2001; Kennedy and Tzaros 2005; Saunders 2002).

5.3.4 Threatening processes

The following have been identified as potentially threatening processes to the Swift parrot:

- Habitat loss associated with breeding sites as well as drought refugia habitat
- Habitat alteration through forestry operations, firewood collection and urbanisation in Tasmania
- Competition with noisy miner and aggressive honeyeaters
- Nest predation by gliders (DES 2017; OEH 2017).

5.3.5 Species resilience

Determination of species resilience is presented in Table 5.3.

5.3.6 References

Atlas of Living Australia (2019). Lathamus discolor. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:3f12e573-a7b7-45e7-a6e4-aeae9bc3a9ed [Accessed 12 September 2019].

Birdlife Australia (2019). Swift Parrot. Available from: http://www.birdlife.org.au/bird-profile/swift-parrot [Accessed 12 September 2019].

Department of Environment and Energy (2019). Lathamus discolor (Swift Parrot) in Species Profile and Threats Database. Australian Government. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=744 [Accessed 12 September 2019].

Department of Environment and Science (2019). Swift parrot. Queensland Government. Available from: https://www.ehp.qld.gov.au/wildlife/animals-az/swift_parrot.html [Accessed 12 September 2019].

eBird Australia. (2015). Swift parrot (Lathamus discolor). [image] [online] Available from: https://images.ala.org.au/image/details?imageId=5fdc44e4-6dcf-4a63-955c-c6ae76f938a1. [17 September 2019].

Higgins, P.J. (ed.) 1999, Handbook of Australian, New Zealand and Antarctic Birds. Volume Four - Parrots to Dollarbird. Melbourne: Oxford University Press.

Kennedy, S.J. and A. Overs 2001, Foraging ecology and habitat use of the Swift parrot on the western slopes of New South Wales. Corella. 25:68-74.

Kennedy, S.J. and C.L. Tzaros 2005, Foraging ecology of the Swift parrot *Lathamus discolor* in the box-ironbark forests and woodlands of Victoria. Pacific Conservation Biology. 11:158-173.

Mallick, S., D. James, R. Brereton and S. Plowright 2004, Blue-gums Eucalyptus globulus in north-west Tasmania: an important food resource for the endangered Swift parrot *Lathamus discolor*. *Victorian Naturalist*. 121:36-46.

Office of Environment and Heritage (2019). Swift Parrot - Profile. New South Wales Government. Available from: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10455 [Accessed 12 September 2019].

Saunders, D. and Heinsohn, R. 2008, Winter habitat use by the endangered, migratory Swift parrot (Lathamus discolor) in New South Wales. Emu. 108:81-89. CSIRO Publishing.

Saunders, D. 2002, Assessment of Swift parrot Sites near Cessnock, Lower Hunter Valley Region, NSW - including the Hunter Employment Zone. Report prepared in response to porposed developments in the Hunter Employment Zone.

Swift Parrot Recovery Team. (2011). Swift Parrot Lathamus discolor recovery plan 2011. Report to Environment Australia, Canberra. Queensland Parks and Wildlife Service, Brisbane.

Table 5.3 Species resilience questionnaire – Swift parrot (*Lathamus discolor*)

Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes **(2)** ▪ Unlikely to change as a result of the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Key threats to this species include: ▪ Habitat loss associated with breeding sites as well as drought refugia habitat ▪ Habitat alteration through forestry operations, firewood collection and urbanisation in Tasmania ▪ Competition with noisy miner and aggressive honeyeaters ▪ Nest predation by gliders. Most of the threatening process to this species are located within this species breading areas (i.e. Tasmania). As breeding habitat for this species does not occur on Mainland Australia, it is not considered that the project will increase threating processes to this species.	0
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ▪ Decline or shift from current location (3) ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species does not breed on mainland Australia (i.e. only breeds in Tasmania). The species does not appear to be restricted to highly specialised environments to facilitate breeding activities. As such Project works are not considered likely to reduce the area of breeding habitat available for the species.	0
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ▪ Decline or shift from current location **(2)** ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities', any impact on this value is expected to have an adverse impact on the species **(120)***	This species forages in a variety of habitat utilising flowering trees as a source of nectar and pollen. Foraging sources are widespread throughout areas adjacent to the activity and it is not expected that the availability of forage for this species will significantly change as a result of the works.	0

Item	Question	Criteria	Species response	Score
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ■ Expected to decrease or habitat components required for breeding unknown (3) ■ Expected to decrease or habitat components required for breeding unknown (3) ■ Unlikely to change **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species does not breed on mainland Australia. The Project works are will not impact any breeding resources for the species.	0
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ■ Expected to decrease or habitat components required for non-breeding unknown **(2)** ■ Unlikely to change **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The species does not appear to require any specific, specialised habitat components to facilitate non-breeding activities. Subsequently, Project works are not expected to significantly impact reduce the quantity of non-breeding habitat resources for the species.	0
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	■ Low ability to disperse **(2)** ■ Mobile, but dispersal is sex-biased (only one sex disperses) **(1)** ■ Very mobile, both sexes disperse **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The species is highly mobile with a high ability to disperse as evident by its wide-ranging nature	0
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	■ Species migratory habitats will be adversely affected **(2)** ■ Species migratory habitats will not be adversely affected **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The Project works will not create a barrier to species movement or separate vital habitats	0

Item	Question	Criteria	Species response	Score
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(2)** ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The species transit and wide-ranging nature allows it to easily disperse to cope with resource fluctuations	0
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ▪ Once per year or less **(2)** ▪ More than once per year **(0)** ▪ *Due to species sensitivities', any impact on this value is expected to have an adverse impact on the species **(120)***	This species does not breed on mainland Australia. The species breeding during a defined period each year.	2
Q10.	Food resources: Are important food resources for this species expected to change?	▪ Primary food source(s) are expected to be negatively impacted by projected changes **(2)** ▪ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Feeding resources for this species are not expected to change because of the Project activities. This species is wide ranging and feeds over a broad area. No impacts are likely to occur.	0
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: ▪ Is expected to increase as a result of the projected changes **(2)** ▪ Is not expected to be impacted by the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Primary threats to this species is nest predation by gliders. As this bird does not breed in the Australian mainland, there is not expected to be an increase in predation to this species as a result of the Project	0

Item	Question	Criteria	Species response	Score
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	▪ Disease prevalence is expected increase with projected changes **(2)** ▪ No known effects of expected changes on disease prevalence (0) ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The nature of works is unlikely to introduce disease that may cause species decline	0
Q13.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes **(2)** ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Competition with honey eaters and Noisy miners may impact upon this species. The creation of edges favour the occurrence of the Noisy miner. Impacts associated with new edges and increased Noisy miner densities may impact this species.	2
Total score				4
Species resilience				**Moderate**

6 Endangered fauna species

6.1 Spot-tailed quoll (*Dasyurus maculatus*)

6.1.1 Status

EPBC Act – Endangered

BC Act - Vulnerable

6.1.2 Biology and ecology

Characteristics

Male Spot-tailed quolls (south-eastern mainland population) (*Dasyurus maculatus maculatus*) have a head-body length of 380 to 759 mm, and females are 350 to 450 mm. Male tail lengths are between 370 to 550 mm and 340 to 420 mm for females. The average male Spot-tailed quoll weighs between 2.8 to 4.6 kg, whilst females average a weight of 1.5 to 2 kg. The fur on its back ranges in colour from rich red-brown to dark brown with white spots (refer Photograph 6.1). The Spot-tailed quoll is distinguished from other quolls by the spots running along the length of its tail. The fur on the underside is cream or white. They also have short, round ears which extend just above the outline of the head. Female Spot-tailed quolls have a poorly developed pouch (Belcher 2003; DotEE 2019; Green and Scarborough 1990; Jones 1997; Körtner et al. 2004; Queensland Museum 2015).

Photograph 6.1 Spot-tailed quoll (Dasyurus maculatus maculatus)

Source: Bennett (2012)

Known distribution

The Spot-tailed quoll (southern subspecies) was previously widely distributed from southeast Queensland, eastern NSW, Victoria, southeast South Australia and Tasmania (refer Figure 6.1), however, it is estimated that the range has reduced by 50 to 90%. Detailed distribution records and abundance estimates are lacking, due to the scale and intensity of survey effort that is required to detect the species across its entire range (Jones et al. 2001; Long and Nelson 2004).

In Queensland, the Spot-tailed quoll occurs in the southeast, coastally from Bundaberg to the NSW border, and inland to Monto and Stanthorpe. Spot-tailed quolls are known from five broad geographic: four from coastal ranges and the Great Dividing Range from the NSW border to Gladstone. The fifth is centered on the eastern Darling Downs-Inglewood Sandstone provinces of the Brigalow Belt South Bioregion. Unconfirmed reports suggest the subspecies may occur in the Clarke and Conway Range areas, eastern Queensland (Long and Nelson 2004; Van Dyck and Longmore 1991).

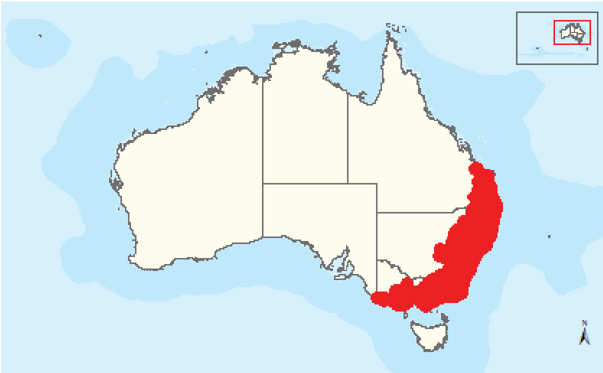


Figure 6.1 Distribution range of the Spotted-tail quoll (southern subspecies)

Source: DotEE (2019)

Biology and reproduction

Spot-tailed quolls are predominantly nocturnal and typically prey on medium-sized mammals. Typically, prey includes Ringtail possum (*Pseudocheirus pererinus*), Common brushtail possum (*Trichosurus vulpecula*), Mountain brushtail possum (*Trichosurus caninus*), Greater gilder (*Petauroides volans*) and Rabbit. Additionally, this species consumes insects, lizards, crayfish, poultry, birds, small mammals, frogs, fish, plant material and refuse that has been discarded by humans (Belcher 1995; 2000; Dawson 2005; Edgar and Belcher 2008; Jones et al. 2001).

Mating and births for the Spot-tailed quoll occur over the winter months (June to August). It is possible for roaming males to mate with more than one female per year (Belcher and Darrant 2004; Dawson 2005; Fleay 1940).

After a gestation period of 21 days, litters of between four and six are born, in late-July to mid-August. Young are attached to the teat for about eight weeks from birth. Subsequently, young may be left in the maternal den while the mother is hunting for food to provide to her young. At 18 to 21 weeks the young are fully independent and 33% of the body size of the mother (Belcher 2003; DotEE 2019; Edgar and Belcher 2008; Fleay 1940; Green and Scarborough 1990; Jones et al. 2001).

6.1.3 Habitat

Spoted-tailed quolls have been recorded from a wide range of habitats, including temperate and subtropical rainforests in mountain areas, wet schlerophyll forest, lowland forests, open and closed eucalypt woodlands, inland riparian and River red gum (*Eucalyptus camaldulensis*) forests, dry 'rainshadow' woodland, sub-alpine woodlands, coastal heathlands and occasionally in open country/other treeless areas. Habitat requirements include suitable den sites such as hollow logs, tree hollows, rock outcrops or caves. From a study in Kosciuszko National Park, home range estimates were 620 to 2560 ha for males, and 90 to 650 ha for females (Edgar and Belcher 2008; Green and Scarborough 1990; Maxwell et al. 1996; NPWS 1999).

The Spot-tailed quoll is known to prefer mature wet forest habitat especially areas with rainfall 600 mm/year. Unlogged forest or forest that has had limited disturbance by timber harvesting is also preferable (Belcher 2000; Catling et al. 1998; 2000; Edgar and Belcher 2008; Green and Scarborough 1990; Mansergh 1984; Watt 1993).

6.1.4 Threatening processes

The following have been identified as potentially threatening processes to the Spot-tailed quoll:

- The loss, fragmentation, disturbance and degradation of habitat through clearing of native vegetation, timber harvesting and other forest management practices (ACT Government 2005; Belcher et al. 2007; Catling and Burt 1995; Catling et al. 1998; Long and Nelson 2004)
- Predation from Red foxes, Dingos (Canis lupus dingo) and Domestic dogs. Dietary and habitat overlap with these species may also be leading to competitive effects (Körtner and Gresser 2002; Long and Nelson 2004; Murray and Poore 2004)
- Spot-tailed quolls have been killed by landholders in response to poultry coop raids. The large home ranges of the Spotted-tail quoll, particularly males, also makes them susceptible to road mortality in forested areas fragmented by roads, and a tendency to scavenge carrion may increase this threat (Dawson 2005; Green and Scarborough 1990; Nelson 2004; Jones 2000 cited in Long and Nelson 2004; Jones et al. 2003; Long and Nelson 2004).
- Following various baiting programs using 1080 baits for invasive predators, the dosage for foxes and dogs is potentially fatal to the Spotted-tail quoll, particularly for smaller individuals, such as females and juveniles (Körtner and Watson 2005).

6.1.5 Species resilience

Determination of species resilience is presented in Table 6.1.

6.1.6 References

ACT Government (2019). *Spotted-tailed Quoll* (Dasyurus maculatus) - *a vulnerable species, Action Plan No. 30*. Canberra: Environment ACT. Available from: http://www.environment.act.gov.au/cpr/conservation_and_ecological_communities/threatened_species_action_plans. [Accessed 12 September 2019]

Belcher, C.A. (1995). Diet of the tiger quoll *(Dasyurus maculatus)* in East Gippsland, Victoria. *Wildlife Research*. 22:341-357.

Belcher, C.A. (2000). *The Ecology of the Tiger Quoll,* Dasyurus maculatus*, in southeastern* Australia. Ph.D. Thesis. Melbourne, Victoria: Deakin University.

Belcher, C.A. (2003). Demographics of tiger quoll *(Dasyurus maculatus maculatus)* populations in southeastern Australia. *Australian Journal of Zoology*. 51:611-626.

Belcher, C.A. and Darrant J.P. (2004). Home range and spatial organization of the marsupial carnivore, *Dasyurus maculatus maculatus* (Marsupialia: Dasyuridae) in southeastern Australia. Journal of Zoology. 262:271-280.

Belcher, C., Nelson J. and Darrant J. (2007). Diet of the tiger quoll *(Dasyurus maculatus)* in southeastern Australia. *Australian Journal of Zoology*. 55:117-122.

Bennett, S. J. (2012). Spotted-tail quoll (southeastern mainland population) (Dasyurus maculatus maculatus). [image] [online] Available from: https://www.flickr.com/photos/quollism/8470326020/in/photolist-otMpsh-dUuCPN-8i5qZD-8FyqvQ-8Fyrj9-8i5v82-8i5fv2-8i5dAx-8i8tbh-dUuJyw-3ibXyv-6ohk1i-6ohoxX-dUp7A8-6ompZ1-6omrpj-a9ZctU-9agNYm-28zD4py-MzPVJP-2bkFCPX. [17 September 2019].

Catling, P.C., Burt R.J. and Forrester R.I. (1998). Models of the distribution and abundance of ground-dwelling mammals in the eucalypt forests of southeastern New South Wales. Wildlife Research. 25(5):449-466.

Table 6.1 Species resilience questionnaire – Spot-tailed quoll (*Dasyurus maculatus maculatus*)

Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes **(2)** ▪ Unlikely to change as a result of the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Known threats to this species include: ▪ Lethal toxic ingestion caused by Cane Toads ▪ Removal, degradation and fragmentation of habitat ▪ Inappropriate fire regimes ▪ Weeds ▪ Feral predators The nature of Project works is not anticipated to have a significant influence upon the distribution of the Cane Toad. Any Project clearing works within areas of species habitat is considered to contribute to threatening processes for the species, that is habitat removal and degradation.	2
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ▪ Decline or shift from current location (3) ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species lives in a variety of habitats including rocky areas, rainforest and eucalypt forest. Any clearing works within areas of species habitat is considered to reduce the area of available breeding habitat for the species.	3
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ▪ Decline or shift from current location **(2)** ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Rocky areas are considered to provide prime habitat for this species as the species is considered vulnerable to external factors such as cattle impacts, predators and cane toads when isolated from rocky refuge habitat. Any clearing works within rocky environments which are identified as species habitat is considered to reduce the area of available non-breeding habitat.	2

Item	Question	Criteria	Species response	Score
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ■ Expected to decrease or habitat components required for breeding unknown (3) ■ Expected to decrease or habitat components required for breeding unknown (3) ■ Unlikely to change **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The habitat area for this this species generally includes rocky areas for denning purposes. Any clearing works within areas of species habitat is considered to reduce the area of available breeding habitat for the species.	3
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ■ Expected to decrease or habitat components required for non-breeding unknown **(2)** ■ Unlikely to change **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species can utilise a range of different habitat types however the presence of suitable denning sites (e.g. Fallen logs, rocky areas, low hollows) is considered a primary factor in identifying areas of preferred habitat. As the species is not reliant on specialised habitat components to facilitate non-breeding activities, Project works are not considered to reduce the quantity of non-breeding habitat components.	0
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	Low ability to disperse **(2)** ■ Mobile, but dispersal is sex-biased (only one sex disperses) **(1)** ■ Very mobile, both sexes disperse **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The species is highly mobile and occurs at low densities. There are no observable differences in the pattern or extent of movements between males and females.	0
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	■ Species migratory habitats will be adversely affected **(2)** ■ Species migratory habitats will not be adversely affected **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species does not appear to have highly specific habitat requirements. There does not appear to be any additional migratory or transitional habitat requirements for the species. The nature of Project works will not create a permanent barrier to movement.	0

Item	Question	Criteria	Species response	Score
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ■ Limited flexible strategies to cope with variable resources across multiple years **(2)** ■ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species is an opportunistic forager that feed on a broad range of items switching dietary resources according to season and availability. Providing suitable habitat remains, the this species does have flexible strategies to cope with resource fluctuation.	0
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ■ Once per year or less **(2)** ■ More than once per year **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Northern quolls breed once each year exhibiting synchronous reproduction within each year at each site. Females do not appear to breed for more than 2 successive seasons.	2
Q10.	Food resources: Are important food resources for this species expected to change?	■ Primary food source(s) are expected to be negatively impacted by projected changes **(2)** ■ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species is an opportunistic omnivore, consuming a wide range of prey including beetles, grasshoppers, spiders, scorpions, centipedes, small mammals and frogs. They are also known to consume fruit, nectar and are known to feed on carrion and human refuse. Due to the abundant nature of species food resources, Project works not anticipated to impact on the species primary food source.	0
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: ■ Is expected to increase as a result of the projected changes **(2)** ■ Is not expected to be impacted by the projected changes **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	European red fox (*Vulpes vulpes*) and dogs (*Canis lupins*) are key threatening processes to this species. Project works are unlikely to result in the spread of invasive species. Any project clearing works within areas of rocky habitat identified as habitat for the species is considered likely to increase the predation vulnerability of the species.	2

Item	Question	Criteria	Species response	Score
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	▪ Disease prevalence is expected increase with projected changes **(2)** ▪ No known effects of expected changes on disease prevalence (0) ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The nature of works is unlikely to introduce disease that may cause species decline	0
Q13.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes **(2)** ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species is susceptible to lethal toxic ingestion caused by Cane toads. This species is particularly vulnerable to this process as they eat several species of native frogs. Project works are unlikely to strongly influence populations of competitor species due to the nature of the works.	0
Total score				14
Species resilience				**Moderate**

Catling, P.C., Burt R.J. and Forrester R.I. (2000). Models of the distribution and abundance of ground-dwelling mammals in the eucalypt forests of north-eastern New South Wales in relation to habitat variables. Wildlife Research. 27:639-654.

Claridge, A.W., Paull D., Dawson J., Mifsud G., Murray A.J, Poore R. and Saxon M.J. (2005). Home range of the spotted-tailed quoll (*Dasyurus maculatus*), a marsupial carnivore, in a rainshadow woodland. *Wildlife Research*. 32(1):7-14.

Dawson, J.P. (2005). *Impact of wildfire on the* Spotted-tail quoll Dasyurus maculatus *in Kosciuszko National Park*. M.Sc. Thesis. University College (Australian Defence Force Academy), University of New South Wales.

Department of the Environment and Energy (2019). *Dasyurus maculatus maculatus (SE mainland population)* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=75184. [Accessed 12 September 2019]

Edgar, R. and Belcher C. (2008). Spotted-tail quoll, *Dasyurus maculatus* (Kerr, 1792). **In:** Strahan, R., ed. *The Mammals of Australia*. Page(s) 61-62. Carlton, Victoria: Reed New Holland.

Fleay, D. (1940). Breeding of the Tiger Cat. *Victorian Naturalist*. 56:159-163.

Green, R.H. and Scarborough T.J. (1990). The Spotted-tail quoll *Dasyurus maculatus* (Dasyuridae, Marsupialia) in Tasmania. *The Tasmanian Naturalist*. 100:1-15.

Jones, M.E., Oakwood M., Belcher C.A., Morris K., Murray A.J., Woolley P.A., Firestone K.B., Johnson B. and Burnett S. (2003). Carnivore Concerns: Problems, issues and solutions for conserving Australasia's marsupial carnivores. In: Jones, M., Dickman C. and Archer M., eds. Predators with Pouches: The biology of carnivorous marsupials. Page(s) 422-434. Collingwood, Victoria: CSIRO Publishing.

Jones, M.E., Rose R.K. and Burnett S. (2001). Dasyurus maculatus. *Mammalian Species*. 676:1-9. American Society of Mammalogists.

Körtner, G. and Gresser S. (2002). *Impact of fox baiting on quoll populations. Final Report to Environment Australia and the New South Wales National Parks and Wildlife Service.*

Long, K.I. and Nelson J.L. (2004). *(Draft) Recovery Plan for* Dasyurus maculatus *(*Spotted-tail quoll*) 2005-2009*. Canberra: Department of the Environment.

Mansergh, I.M. (1984). The status, distribution and abundance of *Dasyurus maculatus* (Tiger Quoll) in Australia with particular reference to Victoria. *Australian Zoologist*. 21:109-122.

Maxwell, S., Burbidge A.A. and Morris K. (1996). *The 1996 Action Plan for Australian Marsupials and Monotremes*. Wildlife Australia, Environment Australia.

Murray, A.J. and Poore R.N. (2004). Potential impact of aerial baiting for wild dogs on a population of spotted-tailed quolls *(Dasyurus maculatus). Wildlife Research*. 31:639-644.

National Parks and Wildlife Service (NPWS) (1999). Spotted-tail quoll*,* Dasyurus maculatus *(Kerr 1792)*. Hurstville, New South Wales: National Parks and Wildlife Service.

Threatened Species Scientific Committee (2004). Commonwealth Listing Advice on *Dasyurus maculatus maculatus* (Spotted-tail quoll, Spotted-tail quoll, Tiger Quoll). [Online].

Van Dyck, S.M. and Longmore, N.W. (1991). The mammal records. **In:** Ingram, G.J. and Raven, R.J., eds. *Atlas of Queensland's Frogs, Reptiles, Birds and Mammals*. Page(s) 284-336. Brisbane: Queensland Museum.

Watt, A. (1993). Conservation status and draft management plan for *Dasyurus maculatus* and *D. hallucatus* in southern Queensland. Queensland: Department of Environment.

6.2 Australasian bittern (*Botaurus poiciloptilus*)

6.2.1 Status

EPBC Act – Endangered

BC Act – Endangered

6.2.2 Biology and ecology

Characteristics

The Australasian bittern (*Botaurus poiciloptilus*) is a large stocky, partially nocturnal heron which can reach up to a total body length of 75 cm with a wingspan just over 1 m. The species has a long narrow neck, a straight brownish-yellow bill which transitions into a dark brown feathering on the side of its neck and becomes pale at the throat. The mottled brown upper surface of the bittern is supported by a buff dark brown striped under surface and pale green legs (refer Photograph 6.2). Bittern juveniles differ from adults due to their paler feathering and heavier buff flecking on the back. Sexes can be differentiated through size as female bittern weigh about 900 g compared to male bittern, who are significantly heavier weighing up to 1,400 g. The physical appearance of the bittern makes it very well camouflaged within its natural habitat and often go unspotted (Birdlife 2019; SWIFFT 2019; TSSC 2011).

Photograph 6.2 Australasian bittern (*Botaurus poiciloptilus*)

Source: Brown (2014)

Known distribution

The Australasian bittern is known to occur in southeastern Australia, extending from Bundaberg through to northern Tasmania (refer Figure 6.2). In NSW, Australasian bittern is predominantly found in the Murray-Darling basin which once formed a stronghold for the species (Birdlife 2019; Birdlife International 2016).

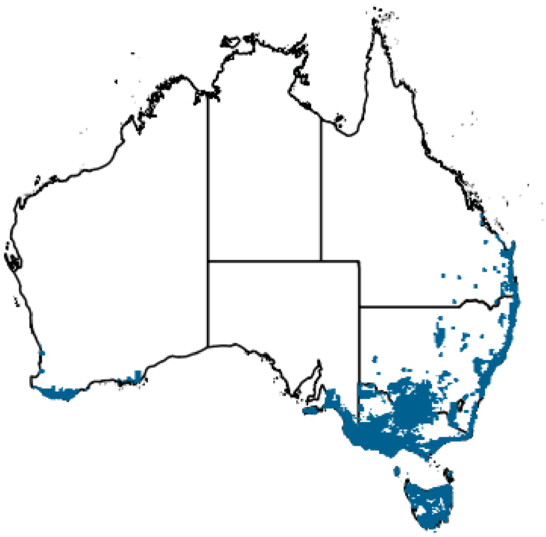


Figure 6.2 **Distribution range of the Australasian bittern**

Source: ALA (2019)

Biology and reproduction

The Australasian bittern is crepuscular and known to hide during day time and come out after sun down. It feeds mainly on frogs, fish, crayfish, spiders, insects and snails. The species constructs a feeding platform over deeper water using reeds trampled by the bird and uses multiple hunting techniques to capture prey (Birdlife 2019; OEH 2019).

The species breed around summer, between October and January, as solitary pairs and begin building nests in secluded, densely vegetated wetlands on platforms of reeds approximately 30 cm above water level. The female Australasian bittern will lay six eggs of olive to brown colour to a clutch and known to have a short incubation period (Birdlife 2019; O'Donnell 2011; TSSC 2011).

6.2.3 Habitat

Preferred habitat for the Australasian bittern consists of permanent freshwater wetlands with tall dense vegetation including bulrushes (*Tyhpa* spp.), spikerushes (*Eleocharis* spp.) and tall emergent sedges. Rice paddies within the Murray-Darling basin are a known habitat for the species who disperse widely during periods of droughts to coastal wetlands and to ephemeral wetlands (Birdlife International 2016; OEH 2019).

6.2.4 Threatening processes

The following have been identified as potentially threatening processes to the Australasian bittern:

- Wetland drainage for agriculture
- Changes brought on by high levels of grazing, drought and salinisation of swamps
- Long term habitat destruction exposing species to predation
- Abandoning nests due to slight disturbances as a result of their sensitive nature (Birdlife International 2016).

6.2.5 Species resilience

Determination of species resilience is presented in Table 6.2.

6.2.6 References

Atlas of Living Australia (2019). Botaurus poiciloptilus. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:47dca80b-ac7c-4130-bef3-4afb4fad35ab [Accessed 10 September 2019].

Birdlife Australia (2019). Australasian Bittern. Available from: http://www.birdlife.org.au/bird-profile/australasian-bittern [Accessed 12 September 2019].

BirdLife International (2016). Botaurus poiciloptilus. The IUCN Red List of Threatened. Available from: http://www.iucnredlist.org/details/22697353/0 [Accessed 12 September 2019].

Brown, C. (2014). Australasian bittern (Botaurus poiciloptilus). [image] [online] Available from: https://images.ala.org.au/image/details?imageId=540dc629-3998-48c0-848a-18e1514a39c5. [17 September 2019].

O'Donnell, Colin. (2011). Breeding of the Australasian Bittern (Botaurus poiciloptilus) in New Zealand. ResearchGate. Available from: https://www.researchgate.net/publication/263002340 [Accessed 10 September 2019].

Office of Environment and Heritage (2019). Australasian Bittern – Profile. New South Wales Government. Available from: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10105 [Accessed 10 September 219].

State Wide Integrated Flora and Fauna Teams (2018). Australasian Bittern. Available from: https://www.swifft.net.au/cb_pages/sp_australasian_bittern.php [Accessed 10 September 2019].

Threatened Species Scientific Committee (2011). Botaurus poiciloptilus in Species Profile and Threats Database. Department of Environment and Energy. Canberra. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/1001-listing-advice.pdf [Accessed 10 September 2019].

Table 6.2 Species resilience questionnaire – Australasian bittern (*Botaurus poiciloptilus*)

Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes **(2)** ▪ Unlikely to change as a result of the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have a adverse impact on the species* ***(120)***	Major threats to the species include habitat loss and degradation (predominately attributed to the drainage or filling-in of wetlands), river regulation and diversion of water away from wetlands for agriculture. High levels of grazing, salinization of swamps, collisions with man-made structures and shooting are additional factors likely to be contributing to the species' decline. Project works will not disturb wetland areas and as such the Project is not anticipated to significant contribute to habitat loss and degradation for the species.	0
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ▪ Decline or shift from current location (3) ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have a adverse impact on the species* ***(120)***	The Australasian bittern breeds in relatively deep, densely vegetated freshwater swamps and pools, building its nests in deep cover over shallow water (Marchant & Higgins 1990). Because of its comparatively specialised habitat requirements (ie densely vegetated wetlands), the species is more sensitive to habitat loss than many other wetland birds (Garnett and Crowley 2000). Project works will not disturb wetland areas and as such the Project is not anticipated to reduce the area of breeding habitat for the species.	0
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ▪ Decline or shift from current location **(2)** ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have a adverse impact on the species* ***(120)***	The species favours permanent and seasonal freshwater habitats, particularly those dominated by sedges, rushes and/or reeds (e.g. *Phragmites*, *Cyperus*, *Eleocharis*, *Juncus*, *Typha*, *Baumea*, *Bolboschoenus*) or Cutting grass (*Gahnia*) growing over muddy or peaty substrate (Marchant & Higgins 1990). Project works will not disturb wetland areas and as such the Project is not anticipated to reduce the area of non-breeding habitat for the species.	0

Item	Question	Criteria	Species response	Score
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ■ Expected to decrease or habitat components required for breeding unknown (3) ■ Expected to decrease or habitat components required for breeding unknown (3) ■ Unlikely to change **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have a adverse impact on the species **(120)***	The species requires densely vegetated wetlands to facilitate breeding (Marchant & Higgins 1990). Project works will not disturb wetland areas and as such the Project is not anticipated to reduce the quantity of breeding habitat components required for the species.	0
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ■ Expected to decrease or habitat components required for non-breeding unknown **(2)** ■ Unlikely to change **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The species forages in still shallow water up to 0.3 m in depth, often at the water's edge, or from platforms or mats of flattened vegetation over deeper water. Project works will not disturb wetland areas and as such the Project is not anticipated to reduce the quantity of non-breeding habitat components required for the species.	0
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	■ Low ability to disperse **(2)** ■ Mobile, but dispersal is sex-biased (only one sex disperses) **(1)** ■ Very mobile, both sexes disperse **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The Australasian bittern does have ability to disperse if its habitat is compromised. The species can occur in high densities in temporary or infrequently filled wetlands during exceptionally wet years, and will also use ephemeral wetlands when irrupting from drying floods.	0
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	■ Species migratory habitats will be adversely affected **(2)** ■ Species migratory habitats will not be adversely affected **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	As the species has been described as sedentary in permanent habitats (TSSC 2011), there does not appear to be any additional migratory or transitional habitat requirements for the species. The nature of Project works are not considered to create a permanent barrier to species movement.	0

Item	Question	Criteria	Species response	Score
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(2)** ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have a adverse impact on the species **(120)***	The Australasian bittern appears to be capable of moving between habitats as habitat suitability changes. The species can occur in high densities in temporary or infrequently filled wetlands during exceptionally wet years, and will also use ephemeral wetlands when irrupting from drying floods (Garnett 1992).	0
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ▪ Once per year or less **(2)** ▪ More than once per year **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The species breeding season occurs between October and February (Marchant & Higgins 1990)	0
Q10.	Food resources: Are important food resources for this species expected to change?	▪ Primary food source(s) are expected to be negatively impacted by projected changes **(2)** ▪ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have a adverse impact on the species **(120)***	In Australia, the bittern has been recorded feeding on freshwater crayfish, fish (including goldfish), weevils, snakes, leaves and fruit (Marchant & Higgins 1990). Frogs and tadpoles are also likely to be eaten (DSEWPaC 2013a). Due to the abundant nature of species food resources, Project works not anticipated to impact on the species primary food sources.	0
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: ▪ Is expected to increase as a result of the projected changes **(2)** ▪ Is not expected to be impacted by the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have a adverse impact on the species **(120)***	The Australasian Bittern is subject to the predation of eggs and juveniles by foxes (*Vulpes vulpes)* and cats (*Felis catus*) (Garnett and Crowley 2000). Project works are unlikely to result in the spread of invasive species, with works subject to the Project PWMP (Santos 2012a).	0

Item	Question	Criteria	Species response	Score
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	- Disease prevalence is expected increase with projected changes **(2)** - No known effects of expected changes on disease prevalence (0) - *Due to species sensitivities, any impact on this value is expected to have a adverse impact on the species **(120)***	The nature of works is unlikely to introduce disease that may cause species decline. Movement of equipment and materials to site subject to the Project PWMP (Santos 2012a).	0
Q13.	Competitors: Are populations of important competing species expected to change?	- Major competitor species are expected to be positively impacted by projected changes **(2)** - Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)** - *Due to species sensitivities, any impact on this value is expected to have a adverse impact on the species **(120)***	There are no major competitors recognised as a key threating process to the Australasian bittern (DSEWPaC 2012a)	0
Total score				0
Species resilience				**High**

6.3 Australian painted snipe (*Rostratula australis*)

6.3.1 Status

EPBC Act – Endangered Marine (CAMBA)

BC Act – Endangered

6.3.2 Biology and ecology

Characteristics

The Australian painted snipe (*Rostratula australis*) is a stocky wading bird approximately 220 to 250 mm in length. It has a long pinkish bill and chestnut-coloured head, with a white ring around the eye and a crown stripe. The back and wings are metallic green and barred with black and chestnut. There is a pale stripe extending from the shoulder into a V down the individuals upper back (refer Photograph 6.3). The adult female is slightly larger and more brightly coloured than the male (DotEE 2019).

Photograph 6.3 Australian painted snipe male (*Rostratula australis*)

Source: eBird Australia (2015)

Known distribution

The Australian painted snipe has been recorded at wetlands in all states and territories of Australia but is most common in eastern Australia, where it has been recorded at scattered locations throughout much of Queensland, NSW, Victoria and southeastern South Australia (refer Figure 6.3). Known distribution has likely declined by approximately 50% in Australia since European settlement (Barrett et al. 2003; Blakers et al. 1984; DotEE 2019; Environment Australia 1997).

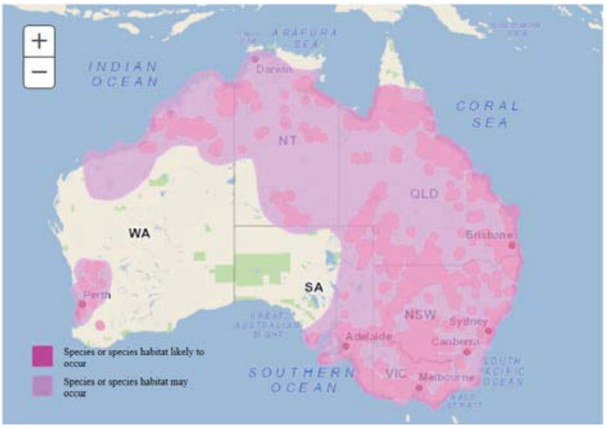


Figure 6.3 **Distribution range of the Australian painted snipe**

Source: DotEE (2019)

Biology and reproduction

The Australian painted snipe eats vegetation, worms, seeds, insects, molluscs, crustaceans and other invertebrates. They are mainly crepuscular and generally remain in dense cover when feeding, although they may forage over nearby mudflats and other open areas such as agricultural land or grassland (Marchant and Higgins 1993).

The Australian painted snipe may breed in response to wetland conditions rather than during a particular season. The species has been recorded breeding in all months in Australia. Their breeding habitat requires shallow wetlands with areas of bare wet mud and with canopy cover nearby. The species nests usually occur on or near small islands in freshwater habitats. Females are known to lay two to six (typically three or four) eggs and may lay up to four clutches in a year and incubation takes 15 to 21 days. The females usually breed every two years (DotEE 2019; Marchant and Higgins 1993).

This species is generally seen alone or in pairs or occasionally in small flocks. Flocking occurs during the breeding season, but are also known to form after the breeding season and at some locations where small groups regularly occur (DotEE 2019; Marchant and Higgins 1993).

6.3.3 Habitat

The Australian painted snipe generally inhabits shallow terrestrial freshwater wetlands, including temporary and permanent lakes, swamps and claypans. The species has also been observed to use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. The Australian painted snipe has been recorded nesting in and near swamps, canegrass swamps, flooded areas, including samphire, grazing land, among cumbungi, sedges, grasses, salt water couch, saltbush (*Halosarcia* sp.) and grass, in ground cover of water-buttons and grasses, at the base of tussocks and under low saltbush (DotEE 2019; Marchant and Higgins 1993).

The Australian painted snipe requires suitable wetland areas even in drought conditions but the species can move to suitable habitat if necessary (Marchant and Higgins 1993).

6.3.4 Threatening processes

The following have been identified as potentially threatening processes to the Australian painted snipe:

- The loss and alteration of wetland habitat, particularly the drainage of wetlands and diversion of water to agriculture and reservoirs therefore reducing flooding and precluding the formation of temporary shallow wetlands (NSW NPWS 1999; Watkins 1993; White 1997)
- Grazing and trampling of wetland vegetation by livestock (NSW NPWS 1999)

- The colonisation of invasive, noxious weeds could render habitats less suitable for the snipe and changes to fire regimes might be affecting savannah vegetation around wetlands in northern Australia (del Hoyo et al. 1996; Garnett and Crowley 2000; NSW NPWS 1999; Rogers et al. 2005; Watkins 1993; White 1997)
- Australian painted snipe nesting sites may also be vulnerable to introduced terrestrial predators such as the European red fox or feral cat (DotEE 2019).

6.3.5 Species resilience

Determination of species resilience is presented in Table 6.3.

6.3.6 References

Aviceda (2002). Photographic image of *Rostratula australis*. [Accessed 10 September 2019]

Barrett, G., Silcocks A., Barry S., Cunningham R. and Poulter R. (2003). *The New Atlas of Australian Birds*. Melbourne, Victoria: Birds Australia.

Blakers, M., Davies S.J.J.F. and Reilly P.N. (1984). *The Atlas of Australian Birds*. Melbourne, Victoria: Melbourne University Press.

del Hoyo, J., Elliott A. and Sargatal J. eds. (1996). *Handbook of the Birds of the World. Volume 3, Hoatzin to Auks*. Barcelona: Lynx Edicions.

Department of the Environment and Energy (2019). *Rostratula australis* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=77037 [Accessed 12 September 2019].

eBird Australia. (2015). Australian painted snipe male (Rostratula australis). [image] [online] Available from: https://images.ala.org.au/image/details?imageId=80919ccc-36ac-463a-9bd9-1462b7a05d1d. [17 September 2019].

Garnett, S.T. and Crowley G.M. (2000). *The Action Plan for Australian Birds 2000*. Canberra, ACT: Environment Australia and Birds Australia.

Marchant, S. and Higgins P.J., eds. (1993). *Handbook of Australian, New Zealand and Antarctic Birds*. Volume 2 - Raptors to Lapwings. Melbourne, Victoria: Oxford University Press.

New South Wales National Parks and Wildlife Service (1999). *Threatened Species Information - Painted Snipe.*

Rogers, D., Hance I., Paton S., Tzaros C., Griffioen P., Herring M., Jaensch R., Oring L., Silcocks A. and Weston M. (2005). The breeding bottleneck: breeding habitat and population decline in the Australian Painted Snipe. In: Straw, P., ed. *Status and Conservation of Seabirds in the East Asian-Australasian Flyway*. Pp. 15-23.

Watkins, D. (1993). A national plan for shorebird conservation in Australia. *RAOU Report Series*. 90.

White, M.E. (1997). *Listen, Our Land Is Crying. Australia's Environment: Problems and Solutions.* Kenthurst, New South Wales: Kangaroo Press

Table 6.3 Species resilience questionnaire – Australian painted snipe (*Rostratula australis*)

Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes **(2)** ▪ Unlikely to change as a result of the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have a adverse impact on the species **(120)***	Key threats to this species include habitat loss and degradation. Other threatening processes include: ▪ The loss and alteration of wetland habitat, particularly the drainage of wetlands and diversion of water to agriculture and reservoirs therefore reducing flooding and precluding the formation of temporary shallow wetlands ▪ Grazing and trampling of wetland vegetation by livestock ▪ The colonisation of invasive, noxious weeds could render habitats less suitable for the snipe and changes to fire regimes might be affecting savannah vegetation around wetlands in northern Australia ▪ Australian painted snipe nesting sites may also be vulnerable to introduced terrestrial predators such as the European red fox or feral cat Due to the nature of the species works will not disturb breeding activities, the project works are not expected to disturb or reduce the quantity of breeding habitat for the species. Furthermore, the species do not appear to be restricted to highly specialised environments to facilitate non-breeding activities and as such the project works are not anticipated to significantly impact on habitat for the species. The nature of project works is not considered to have a significant contribution to the aforementioned threatening processes for the species.	0
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ▪ Decline or shift from current location (3) ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The species does not appear to be restricted to highly specialised environments to facilitate breeding activities. As such Project works are not considered likely to reduce the area of breeding habitat available for the species.	0

Item	Question	Criteria	Species response	Score
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ▪ Decline or shift from current location **(2)** ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities', any impact on this value is expected to have an adverse impact on the species **(120)***	This species forages in a variety of wetland environments. The species have been recorded foraging in in natural and modified environments. Thus, the species does not appear to be restricted to highly specialised environments to facilitate non-breeding activities. However, habitat for this species will be removed as part of the project.	2
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Unlikely to change **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species is not considered reliant on specialised habitat components to facilitate breeding and as such Project works are not expected to significantly impact any breeding habitat resources for the species.	0
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ▪ Expected to decrease or habitat components required for non-breeding unknown **(2)** ▪ Unlikely to change **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The species does not appear to require any specific, specialised habitat components to facilitate non-breeding activities. Subsequently, Project works are not expected to significantly impact reduce the quantity of non-breeding habitat resources for the species.	0
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	▪ Low ability to disperse **(2)** ▪ Mobile, but dispersal is sex-biased (only one sex disperses) **(1)** ▪ Very mobile, both sexes disperse **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The species is very mobile with a high ability to disperse as evident by its migratory nature	0

Item	Question	Criteria	Species response	Score
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	▪ Species migratory habitats will be adversely affected **(2)** ▪ Species migratory habitats will not be adversely affected **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The Project works will not create a barrier to species movement or separate vital habitats	0
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(2)** ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Studies on the behaviour of migratory marine birds that are similar to this species have found many species are able to compensate for habitat deterioration in one area by using other areas more heavily or returning when the disturbance declines, for example by foraging at night. The species transit nature allows it to easily disperse to cope with resource fluctuations. Migratory marine species are considered to have the appropriate flexible strategies to cope with resource fluctuations.	0
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ▪ Once per year or less **(2)** ▪ More than once per year **(0)** ▪ *Due to species sensitivities', any impact on this value is expected to have an adverse impact on the species **(120)***	This species has the potential to breed multiple times during a single year	0
Q10.	Food resources: Are important food resources for this species expected to change?	▪ Primary food source(s) are expected to be negatively impacted by projected changes **(2)** ▪ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species is omnivorous, consuming plant as well as animal material. As the species do not have highly specialised dietary requirements and the primary food resource is abundant, Project works not anticipated to impact on the species primary food source.	0

Item	Question	Criteria	Species response	Score
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: - Is expected to increase as a result of the projected changes **(2)** - Is not expected to be impacted by the projected changes **(0)** - *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species is vulnerable to predation by introduced species including Wild dogs (*Canis familiaris*), Feral cats (*Felis catus*) and Dingoes (*Canis familiaris*). Project works are unlikely to result in the spread of invasive species. With consideration to the highly mobile nature of the species and that the species are not restricted to specialised habitat components, the project works are not considered likely to increase the predation vulnerability of the species.	0
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	- Disease prevalence is expected increase with projected changes **(2)** - No known effects of expected changes on disease prevalence (0) - *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The nature of works is unlikely to introduce disease that may cause species decline	0
Q13.	Competitors: Are populations of important competing species expected to change?	- Major competitor species are expected to be positively impacted by projected changes **(2)** - Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)** - *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	There are no major competitors recognised as a key threating process to the migratory marine species subject to this assessment	0
Total score				2
Species resilience				**High**

7 Vulnerable fauna species

7.1 Border thick-tailed gecko (*Uvidicolus sphyrurus*)

7.1.1 Status

EPBC Act – Vulnerable

BC Act – Vulnerable

7.1.2 Biology and ecology

Characteristics

The Border thick-tailed Gecko is a small lizard up to 10 cm long (average 7 cm). It is fawn to brown above with faint darker brown flecks and many small white spots arranged in rows across the head, back and sides and on the legs. The gecko looks 'knobbly' due to numerous conical tubercles, especially on the tail. The tail is fat and rectangular with a thin tapering tip, and typically has four pale rings. The species has recently been re-assigned to the genus Uvidicolous. These Geckos are active at night and shelter by day under rock slabs, in or under logs, and under the bark of standing trees (DotEE 2019, OEH 2019)

Photograph 7.1 Border thick-tailed gecko (*Uvidicolus sphyrurus*)

Source: Fordyce & White (2018)

Known distribution

Found only on the tablelands and slopes of northern NSW and southern Queensland, reaching south to Tamworth and west to Moree. Most common in the granite country of the New England Tablelands. Occurs at sites ranging from 500 to 1,100 m elevation. Populations are mostly fragmented, with over 50 discrete sites currently known that are separated by at least 2 km (DotEE 2019, OEH 2019).

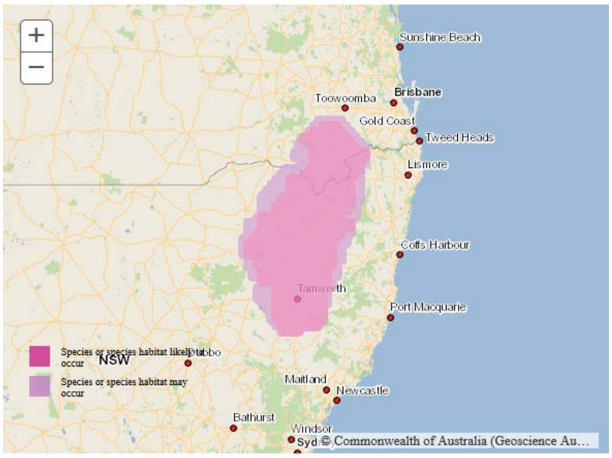


Figure 7.1 **Distribution range of the Border thick-tailed gecko (*Uvidicolus sphyrurus*)**

Source: DotEE (2019)

7.1.3 Habitat

As implied by another of its common names (Granite thick-tailed Gecko), the species often occurs on steep rocky or scree slopes, especially granite in dry eucalypt forest or woodland. Records from basalt and metasediment slopes and flats indicate its habitat selection is broader than formerly thought and may have extended into areas that were cleared for agriculture.

Favours forest and woodland areas with boulders, rock slabs, fallen timber and deep leaf litter. Occupied sites often have a dense tree canopy that helps create a sparse understorey.

7.1.4 Threatening processes

Threatening processes listed for this species include:

- Clearing and fragmentation of areas of rocky dry open forest and woodland for agriculture and development
- Removal of bushrock
- Frequent burning of rocky dry open forest or woodland
- Removal of fallen timber for firewood
- Grazing and trampling of habitat by domestic stock and feral goats
- Predation by foxes and feral cats
- Poor knowledge of species' distribution and population dynamics
- Infestation by weeds, particularly coolatai grass and garden escapees.

7.1.5 Species resilience

Species resilience determination shown in Table 7.1.

Table 7.1 Species resilience questionnaire - Border thick-tailed gecko (*Uvidicolus sphyrurus*)

Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes **(2)** ▪ Unlikely to change as a result of the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Key threats to this species include: ▪ Clearing and fragmentation of areas of rocky dry open forest and woodland for agriculture and development (NSW OEH 2013p). ▪ Removal of bushrock for gardens or the removal of fallen timber for firewood (NSW OEH 2013p). ▪ Too frequent burning of rocky dry open forest or woodland (NSW OEH 2013p). ▪ Grazing and trampling of habitat by domestic stock and feral goats (NSW OEH 2013p). ▪ Predation by foxes and feral cats (NSW OEH 2013p). ▪ Invasive exotic grasses, particularly dense stands of Coolatai Grass (*Hyparrhenia hirta*) (Spark in litt. 2009 cited in NSW SC 2010b). ▪ Disturbance of habitat during native forest logging operations (Cogger et al. 1993). ▪ Inundation by dam construction (Cogger et al. 1993). Project works which require clearing and the removal surface debris has the potential to significantly impact upon this species. This is likely to increase the threatening processes for this species within the vicinity of the project	2
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ▪ Decline or shift from current location (3) ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Areas of breeding habitat will be removed as part of the proposed works	2

Item	Question	Criteria	Species response	Score
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ■ Decline or shift from current location **(2)** ■ Stay the same and in approximately the same location **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Areas of non-breeding habitat will be removed as part of the proposed works	2
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ■ Expected to decrease or habitat components required for breeding unknown (3) ■ Expected to decrease or habitat components required for breeding unknown (3) ■ Unlikely to change **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Breeding habitat components expected to decrease	3
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ■ Expected to decrease or habitat components required for non-breeding unknown **(2)** ■ Unlikely to change **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Non-breeding habitat components will decrease in response to project activities	3
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	■ Low ability to disperse **(2)** ■ Mobile, but dispersal is sex-biased (only one sex disperses) **(1)** ■ Very mobile, both sexes disperse **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species has a poor dispersal ability and has limited ability to colonize new areas of habitat. and has a high potential to colonize new areas of habitat.	2
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	■ Species migratory habitats will be adversely affected **(2)** ■ Species migratory habitats will not be adversely affected **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Species migratory patterns are not likely to be altered in response to the project activities	0

Item	Question	Criteria	Species response	Score
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(2)** ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species has flexible feeding mechanisms and life history attributes to allow it to cope with resource fluctuations	0
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ▪ Once per year or less **(2)** ▪ More than once per year **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	More than once per year	0
Q10.	Food resources: Are important food resources for this species expected to change?	▪ Primary food source(s) are expected to be negatively impacted by projected changes **(2)** ▪ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Species consumes a variety of prey	0
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: ▪ Is expected to increase as a result of the projected changes **(2)** ▪ Is not expected to be impacted by the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Increased levels of predation and the species vulnerability is not expected to be impacted by the project activities	0

Item	Question	Criteria	Species response	Score
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	▪ Disease prevalence is expected increase with projected changes **(2)** ▪ No known effects of expected changes on disease prevalence (0) ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The nature of works is unlikely to introduce disease that may cause species decline	0
Q13.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes **(2)** ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	There are no major competitors recognised as a key threating process to this species. No change is expected.	0
Total score				14
Species resilience				**Moderate**

7.1.6 References

Atlas of Living Australia. 2019. Uvidicolus sphyrurus – Border Thick-Tailed Gecko. Available online at: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:7a6bad30-8da4-4fb4-b0e9-c8a01a95d11d [Viewed 18 September 2019]

Department of the Environment and Energy 2019 Threatened species and ecological communities – SPRAT - Uvidicolus sphyrurus — Border Thick-tailed Gecko, Granite Belt Thick-tailed Gecko available online at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=84578 [Viewed 18 September 2019]

Fordyce, N. and White, J. (2018). Border thick-tailed gecko (*Uvidicolus sphyrurus*). [image] [online] Available from: https://images.ala.org.au/image/details?imageId=7be19574-e16a-4847-b5b2-43a3ce231789. [19 September 2019].

Office of Environment and Heritage 2019 Threatened Species - Border Thick-tailed Gecko – profile. Available online at: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10823 [Viewed 18 September 2019]

7.2 Red goshawk (*Erythrotriorchis radiatus*)

7.2.1 Status

EPBC Act – Vulnerable

BC Act – Critically Endangered

7.2.2 Biology and ecology

Characteristics

The Red goshawk (*Erythrotriorchis radiatus*) is a large, swift and powerful rufous-brown goshawk. This species of raptor is estimated to be of 45 to 58 cm in total body length with a wingspan of 110 to 135 cm. The Red goshawk is boldly mottled and streaked, with rufous scalloping on the back and upper wings, and massive yellowish legs and feet. The head of the bird is pale and streaked with darker feathers (refer Photograph 7.2). Females are typically larger than males, more powerfully built, paler and more heavily streaked below, showing some white on the under body. Red goshawk juveniles are distinguished from adults due to their rufous head (DES 2019; DotEE 2019).

Photograph 7.2 Red goshawk (*Erythrotriorchis radiatus*)

Source: ALA (2016)

Known distribution

The Red goshawk is distributed along the east coast of Queensland, Cape York Peninsula and across into northern regions of Australia (refer Figure 7.2). In Queensland, is it estimated that the species population is limited to the bioregions of the Wet Tropics, Cape York Peninsula and Mount Isa Inlier. However, surveying of the species in another three bioregions has yet to occur. Some adults of Red goshawk in southeast Australia have been known to migrate annually from the ranges down into the lowlands during winter period. The species is thought to be extinct in southeast Queensland as well as being very rare in NSW extending south to about 30°S (DES 2019; OEH 2019).

Figure 7.2 Distribution range of Red goshawk

Source: ALA (2016)

Biology and reproduction

The solitary Red goshawk is known to prey on birds such as Australian brush-turkeys, Kookaburras and Rainbow lorikeet as well as small mammals, reptiles and insects. The species is known to attack its prey from the air, gliding straight down or chasing it down. The male of the species will build nests using dead sticks lined with twigs and green leaves within an exposed fork in the upper quarter of a tree between 10 to 20 m above ground and used each year (DES 2019; OEH 2019).

The breeding season for Red goshawk occurs from September to December with one to two eggs being laid by the females between August and October in the southeast regions. Females will incubate eggs for a period of 39 to 43 days with the young being fully fledged after eight weeks despite not being independent for at least another ten weeks (DES 2019).

7.2.3 Habitat

The Red goshawk typically occurs in both coastal and sub-coastal areas, in wooded and forested lands of tropical and warm-temperate Australia. Riverine forests are also used frequently. The Red goshawk nests in large trees, frequently the tallest and largest in a stand, which are typically within one kilometre of a permanent water source. This species typically avoids very dense, and very open habitats (Debus 1991; 1993; OEH 2017; Marchant and Higgins 1993).

In Queensland the species is known to inhabit cleared parts of eastern Queensland associated gorges and escarpment country whilst in NSW the preferred habitat includes mixed subtropical rainforest such as *Melaleuca* swamp forest as well as riparian *Eucalyptus* forest of coastal rivers (DES 2019; OEH 2019).

7.2.4 Threatening processes

The following have been identified as potentially threatening processes to the Red goshawk:

- Heavy habitat fragmentation caused by urban development, agriculture and forestry processes clearing extensive areas of forests
- Vulnerability of nests to storm damage and prey
- Development or noise dispersing food sources (DES 2019).

7.2.5 Species resilience

Determination of species resilience is presented in Table 7.2.

7.2.6 References

Atlas of Living Australia (2019). Erythrotriorchis radiatus. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:1405a1d4-557c-40ac-9f44-a6d41e9136cd#overview [Accessed 12 September 2019].

Debus, S.J.S. (1991). An annotated list of NSW records of the Red goshawk. Australian Birds. 24:72- 89

Debus, S.J.S. (1993). The status of the Red goshawk (Erythrotriorchis radiatus) in New South Wales. Olsen, P., ed. Australasian Raptor Studies. Page(s) 182-191. ARA-RAOU, Melbourne

Department of Environment and Energy (2019). Erythrotriorchis radiatus (Red Goshawk) in Species Profile and Threats Database. Australian Government. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=942 [Accessed 12 September 2019].

Department of Environment and Science (2019). Red Goshawk. Queensland Government. Available from: https://www.ehp.qld.gov.au/wildlife/threatened-species/endangered/endangered-animals/red_goshawk.html [Accessed 12 September 2019].

Table 7.2 **Species resilience questionnaire – Red goshawk (*Erythrotriorchis radiatus*)**

Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes **(2)** ▪ Unlikely to change as a result of the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Key threats to this species include: ▪ Heavy habitat fragmentation caused by urban development, agriculture and forestry processes clearing extensive areas of forests ▪ Vulnerability of nests to storm damage and prey ▪ Development or noise dispersing food sources Project works which require clearing and the removal have potential for this species. However, this will occur in an existing fragmented environment and is unlikely to contribute toward threatening processes for this species	0
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ▪ Decline or shift from current location (3) ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Breeding habitat is not expected to be cleared as part of the project works.	0
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ▪ Decline or shift from current location **(2)** ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Non-breeding habitat will be cleared as part of the project works.	2
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Unlikely to change **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Breeding habitat components will remain unaltered in response to project activities	0

Item	Question	Criteria	Species response	Score
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ▪ Expected to decrease or habitat components required for non-breeding unknown **(2)** ▪ Unlikely to change **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Non-breeding habitat components will remain unaltered in response to project activities	0
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	Low ability to disperse **(2)** ▪ Mobile, but dispersal is sex-biased (only one sex disperses) **(1)** ▪ Very mobile, both sexes disperse **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This is a highly vagile species and has a high potential to colonize new areas of habitat.	0
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	▪ Species migratory habitats will be adversely affected **(2)** ▪ Species migratory habitats will not be adversely affected **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Species migratory patterns are not likely to be altered in response to the project activities	0
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(2)** ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species has flexible strategies to cope with resource fluctuations	0
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ▪ Once per year or less **(2)** ▪ More than once per year **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Only a single clutch is produced each year	2

Item	Question	Criteria	Species response	Score
Q10.	Food resources: Are important food resources for this species expected to change?	■ Primary food source(s) are expected to be negatively impacted by projected changes **(2)** ■ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species feeds on a variety of animals and forages over a wide area. Important food resources are not expected to change as a result of the project.	0
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: ■ Is expected to increase as a result of the projected changes **(2)** ■ Is not expected to be impacted by the projected changes **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Increased levels of predation and the species vulnerability is not expected to be impacted by the project activities	0
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	■ Disease prevalence is expected increase with projected changes **(2)** ■ No known effects of expected changes on disease prevalence (0) ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The nature of works is unlikely to introduce disease that may cause species decline	0
Q13.	Competitors: Are populations of important competing species expected to change?	■ Major competitor species are expected to be positively impacted by projected changes **(2)** ■ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	There are no major competitors recognised as a key threating process to this species. No change is expected.	0
Total score				4
Species resilience				**Moderate**

Marchant, S. and P.J. Higgins, eds. (1993). Handbook of Australian, New Zealand and Antarctic Birds. Volume 2 - Raptors to Lapwings. Melbourne, Victoria: Oxford University Press.

Office of Environment and Heritage (2019). Red Goshawk – Profile. New South Wales Government. Available from: https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10279 [Accessed 12 September 2019].

7.3 Grey-headed flying-fox (*Pteropus poliocephalus*)

7.3.1 Status

EPBC Act – Vulnerable

BC Act – Vulnerable

7.3.2 Biology and ecology

Characteristics

The Grey-headed flying-fox (*Pteropus poliocephalus*) weighs approximately 600 g to 1 kg, and typically measures 23 cm to 28 cm from head to body. The Grey-headed flying fox exhibits a collar of orange/brown around its neck, whilst its head is covered in light grey. The fur on the body is grey, often with flecks of white and ginger (refer Photograph 7.3). The fur on the back exhibits two morphs, which are possibly related to age, moult, or sub-population. Winter fur is typically darker than summer fur, and pronounced moulting is known to occur in June (DotEE 2019; Eby and Lunney 2002; Hall 1987; Hall and Richards 2000; Tidemann 1998).

Photograph 7.3 Grey-headed flying-fox (*Pteropus poliocephalus*)

Source: Leo (2010)

Known distribution

The Grey-headed flying-fox occurs in the coastal belt of Eastern Australia, typically ranging from Rockhampton in central Queensland to Melbourne in Victoria (refer Figure 7.3). It is noted that only a small portion of this range is used at any one time, as the species selectively forages where resources are available (DotEE 2019; Tidemann 1998).

The availability of food resources have a direct influence on the occurrence and relative abundance within the Grey-headed flying foxes distribution in various seasons and years (Pallin 2000; Hall 2002; van der Ree et al. 2006).

Figure 7.3 Distribution range of the Grey-headed flying-fox

Source: ALA (2019)

Biology and reproduction

Nectar and pollen from *Eucalyptus*, *Corymbia, Angophora, Melaleuca*, and *Banksia* species are considered the primary food source for Grey-headed flying foxes. This species is known to supplement its diet with a wide range of rainforest fruits and introduced species (Duncan et al. 1999; Eby 1995; 1998; Hall and Richards 2000; Parry-Jones and Augee 1991).

Mating is known to occur in the early autumn months, after which time the larger camps begin to separate, reforming in late spring/early summer when food resources become more abundant. Males and females typically separate in October, when the young are born. Each year, following six months of gestation, females bear a single young. For one month after giving birth, the mother carries her offspring on her ventral surface to feeding sites. When completely furred, the young are left in maternal camps, and are nursed until they are independent, at approximately 12 weeks of age. Sexual maturity typically occurs at about three years of age (DotEE 2019; Hall and Richards 2000; Martin 2000; Nelson 1965; Tidemann 1998).

7.3.3 Habitat

The Grey-headed flying-fox is a canopy-feeding species that eats fruit and nectar. This species utilises a range of vegetated habitats, including rainforests, open forests, closed and open woodlands, *Melaleuca* swamps and *Banksia* woodlands. In an urban setting, this species is known to feed on commercial fruit crops, and on introduced tree species (DotEE 2019).

Roost sites are generally located near water bodies. This species is known to roost in vegetation ranging from rainforest, *Melaleuca* stands, mangroves and riparian vegetation. The species has a high level of roost site fidelity, although new sites have been known to be colonised (Lunney and Moon 1997; Nelson 1965; Ratcliffe 1931; Tidemann and Vardon 1997; van der Ree et al 2005).

7.3.4 Threatening processes

The following have been identified as potentially threatening processes to the Grey-headed flying-fox:

- Clearing of native vegetation for agriculture and forestry operations has accelerated the destruction and disturbance of roosting and foraging habitats of the species in eastern Australia (DotEE 2019; Duncan et al. 1999; SEAC 1996; Teagle 2002)
- Lack of foraging resources can also force Grey-headed flying-foxes into commercial fruit crops, increasing conflict with growers and subsequent culling of individuals (DotEE 2019)

- Urban-dwelling Grey-headed flying-foxes can accumulate lethal levels of lead from the environment and are prone to electrocution on powerlines (DotEE 2019; Hariono et al. 1992)
- Displacement leading to competition and hybridisation with the Black Flying-fox (*P. alecto*) is also a known threat (DotEE 2019; Duncan et al. 1999; SEAC 1996; Teagle 2002).

7.3.5 Species resilience

Determination of species resilience is presented in Table 7.3.

7.3.6 References

Atlas of Living Australia (2019). *Pteropus poliocephalus*. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:a2553aed-383a-4c9b-9534-c6058bcee81b# [Accessed 11 September 2019].

Department of the Environment and Energy (2019). *Pteropus poliocephalus* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=186 [Accessed 11 September 2019].

Duncan, A., Baker, G.B and Montgomery, N. (1999), *The Action Plan for Australian Bats.* [Online]. Canberra: Environment Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/action/bats/index.html. [Accessed 13 September 2019].

Eby, P. and Lunney, D. (2002), *Managing the Grey-headed flying-fox as a threatened species in NSW*. In: Proceedings of the Royal Zoological Society of New South Wales. Mosman, Sydney: Royal Zoological Society of New South Wales.

Hall, L. and Richards, G. (2000), *Flying Foxes: Fruit and Blossom of Australia*. Sydney: University of New South Wales Press.

Hall, L. (1987), Identification, distribution and taxonomy of Australian flying-foxes (Chiroptera: Pteropodidae). Australian Mammalogy. 10 (2):75-81.

Hall, L.S. (2002), *Management of flying fox camps: what have we learnt in the last twenty five years?* In: Eby, P. and D. Lunney, eds. Managing the Grey-headed flying-fox as a Threatened Species in NSW. Page(s) 215-224. Mosman, NSW; Royal Zoological Society of NSW.

Hariono, B., Ng J. and Sutton R.H. (1992). Lead concentrations in tissues of fruit bats (*Pteropus* sp.) in urban and non-urban areas. *Wildlife Research*. 20.

Leo (2010). *Pteropus poliocephalus*. (Image) [Online] Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:a2553aed-383a-4c9b-9534-c6058bcee81b [Accessed 11 September 2019].

Martin, L. (2000), Aspects of the Reproductive Biology of the Grey-headed flying-foxes that explain documented population declines, and support a threatened status. In: Proceedings of a Workshop to Assess the Status of the Grey-headed flying-fox in New South Wales. Unpublished report to the NSW Threatened Scientific Committee.

Nelson, J.E. (1965), Movements of Australian flying foxes (Pteropodidae: Megachiroptera). Australian Journal of Zoology. 13:53-73.

Pallin, N. (2000), Ku-ring-gai Flying-fox Reserve: habitat restoration project, 15 years on. Ecological Management and Restoration. 1:10-20.

Ratcliffe, F.N. (1931), *The flying fox (Pteropus) in Australia*. CSIRO Bulletin. 52:1-133.

State of the Environment Advisory Council (1996). *Australia: State of the Environment 1996.*

Table 7.3 **Species resilience questionnaire – Grey-headed flying- fox (*Pteropus poliocephalus*)**

Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes **(2)** ▪ Unlikely to change as a result of the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Key threats to this species include: ▪ Disruption to feeding resources ▪ Agricultural/horticultural practices Project works which require clearing and the removal have potential to significantly impact upon this species, however these impacts are unlikely to be significant in the context of the surrounding landscape of large woody debris and ground cover are considered to contribute to habitat loss and degradation for the species.	0
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ▪ Decline or shift from current location (3) ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	There are no camps of this species within the proposed disturbance area. There are no impacts expected.	0
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ▪ Decline or shift from current location **(2)** ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species forages over an extensive area during its nocturnal activity period. Given the fast distances travelled, it is not expected that removal of forage sources associated with the project will result in a significant impact to this species.	0
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Unlikely to change **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	No camps are proposed to be disturbed as part of the project activities. Therefore, there is expected that there will be no change to breeding resources for this species.	0

Item	Question	Criteria	Species response	Score
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ▪ Expected to decrease or habitat components required for non-breeding unknown **(2)** ▪ Unlikely to change **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Given the species wide foraging range, it is unlikely there will be a significant change to specific habitat features to this species as a result of the project	0
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	Low ability to disperse **(2)** ▪ Mobile, but dispersal is sex-biased (only one sex disperses) **(1)** ▪ Very mobile, both sexes disperse **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This is a highly vagile species and has a high potential to colonize new areas of habitat. Specimens have been identified changing camp sites as a result of fluctuating resources associated with plant flowering and fruiting periods.	0
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	▪ Species migratory habitats will be adversely affected **(2)** ▪ Species migratory habitats will not be adversely affected **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Species migratory patterns are not likely to be altered in response to the project activities	0
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(2)** ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The Grey-headed flying-fox is highly vagile and has flexible strategies to cope with variable resource availability	0
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ▪ Once per year or less **(2)** ▪ More than once per year **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Only a single offspring is produced each year	2

Item	Question	Criteria	Species response	Score
Q10.	Food resources: Are important food resources for this species expected to change?	▪ Primary food source(s) are expected to be negatively impacted by projected changes **(2)** ▪ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species feeds on a variety of blossoms and fruit, and forages over a wide area. Important food resources are not expected to change as a result of the project.	0
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: ▪ Is expected to increase as a result of the projected changes **(2)** ▪ Is not expected to be impacted by the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Increased levels of predation and the species vulnerability is not expected to be impacted by the project activities	0
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	▪ Disease prevalence is expected increase with projected changes **(2)** ▪ No known effects of expected changes on disease prevalence (0) ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The nature of works is unlikely to introduce disease that may cause species decline	0
Q13.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes **(2)** ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	There are no major competitors recognised as a key threating process to this species. No change is expected.	0
Total score				0
Species resilience				**High**

Teagle, S. (2002). Flying fox Consultative Committee - Formation, Outcomes and Future Strategies. In: Eby, P. and D. Lunney, eds. *Managing the Grey-headed Flying-fox as a Threatened Species in NSW*. Page(s) 109-116. Mosman, NSW: Royal Zoological Society of NSW.

Tidemann, C. and Vardon, M. (1997), *Pests, pestilence, pollen and pot-roasts: the need for community-based management of flying foxes in Australia*. Australian Biologist. 10(1):77-83. hs Forest: New Holland Publishers Pty Ltd.

Tidemann, C.R. (1998), *Grey-headed flying-fox, Pteropus poliocephalus,* Temminck, 1824. In: Strahan, R., ed. The Mammals of Australia. Frenc.

van der Ree, R., McDonnell, J. Temby, I. Nelson, J. and Whittingham, E. (2005), The establishment and dynamics of a recently established urban camp of flying foxes (*Pteropus poliocephalus*) outside their geographic range. Journal of Zoology. 268:177-185. The Zoological Society of London.

van der Ree, R., McDonnell, M.J. Temby, I. Nelson, J. and Whittingham, E. (2006), The establishment and dynamics of a recently established urban camp of Pteropus ploiocephalus outside their geographic range. Journal of Zoology London. 268:177-185.

7.4 Corben's long-eared bat (*Nyctophilus corbeni*)

7.4.1 Status

EPBC Act – Vulnerable

BC Act – Vulnerable

7.4.2 Biology and ecology

Characteristics

The Corben's long-eared bat (*Nyctophilus corbeni*) is a relatively large microchiropteran bat species with a head and body length approximating 50 to 75 mm in length and tail length approximately 35 to 50 mm. The bat has long ears and a shallow muzzle ridge groove with dark-grey brown fur and slightly lighter tips (refer Photograph 7.4). The weight varies between genders with females weighing 14 to 21 g and being heavier than males who weigh 11 to 15 g. The body of the bat is covered with light brown fur (DES 2019; DotEE 2019).

Photograph 7.4 South eastern long-eared bat (*Nyctophilus corbeni*)

Source: Zell (2019)

Known distribution

The South eastern long-eared bat has a limited distribution restricted to the Murray-Darling Basin in south eastern Australia (DotEE 2019) (refer Figure 7.4).

In Queensland, the majority of records for this species are from the Brigalow Belt South Bioregion, with the most easterly record from the Bunya Mountains National Park. The most northerly records are from the Expedition Range and Dawson River areas with the most westerly records from west of Bollon in the Mulga lands Bioregion. In NSW, the species is often found in north eastern NSW (DES 2019; DotEE 2019; OEH 2019; Schulz and Lumdsen 2010).

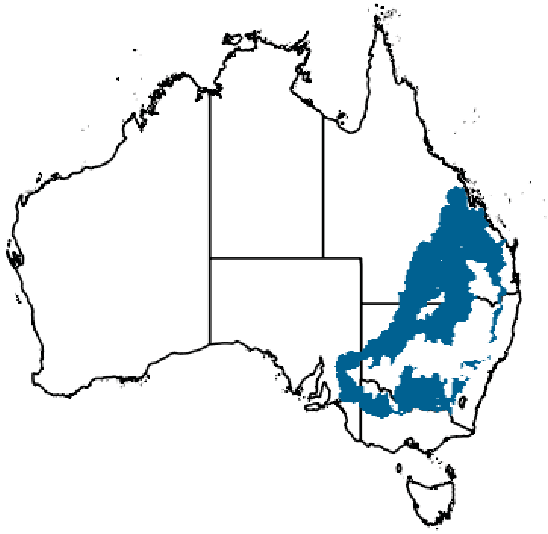


Figure 7.4 Distribution range of the South eastern long-eared bat

Source: ALA (2019)

Biology and reproduction

The bat species feeds on insects which they hunt from foliage and on the ground eating beetles, bugs, moths, grasshoppers and crickets (DES 2019).

There is little information currently available on this species reproductive biology, although it is thought that mating takes place during autumn and winter. Females are thought to store sperm until spring, when fertilisation and gestation occurs. Up to two young are born during late spring/early summer with young not fully weaned until mid-summer (OEH 2019; Curtis et al. 2012).

7.4.3 Habitat

This species is known to inhabit a range of inland woodland vegetation types including; box, ironbark, cypress pine, mallee, bull-oak, brigalow and belah woodlands/forests. The species will roost in tree hollows, crevices and under loose bark within these communities (OEH 2019).

Essential habitat for the species is generally associated with large tracts of vegetation (100s to 1,000s of ha), including; open forest with open to dense understorey Semi Evergreen Vine Thicket/Brigalow/Belah communities and mixed Eucalyptus/Corymbia/Angophora communities. The species is known to fly large distances (>7 km in a night) from roosts to foraging areas (DES 2019; DotEE 2019).

7.4.4 Threatening processes

The following have been identified as potentially threatening processes to the South eastern long-eared bat:

- Habitat loss and/or fragmentation
- Destruction of roosting sites and foraging habitat through fire
- Overgrazing and forestry activity
- Predation by feral species and competition for tree hollows
- Exposure to agrichemicals (DES 2019).

7.4.5 Species resilience

Determination of species resilience is presented in Table 7.4.

7.4.6 References

Atlas of Living Australia (2019) *Nyctophilus corbeni.* Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:8a111847-ee8b-4739-935f-248d37eb63ae [Accessed 11 September 2019].

Department of Environment and Energy (2019). *Nyctophilus corbeni* (Corben's Long-eared Bat) Species Profile and Threats Database. Australian Government. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=83395 [Accessed 11 September 2019].

Department of Environment and Science (2019). Eastern long-eared bat. Queensland Government. Available from: https://www.ehp.qld.gov.au/wildlife/animals-az/micro-bats/eastern_longeared_bat.html [Accessed 11 September 2019].

Office of Environment and Heritage (2019). Corben's Long-eared Bat - Profile. New South Wales Government. Available from: https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10568 [Accessed 12 September 2019].

Schulz, M. and Lumsden, L. (2010). (Draft) National Recovery Plan for the Southeastern long-eared bat *Nyctophilus corbeni*, Victorian Department of Sustainability and Environment

Zell, M. (2019). Southeastern long-eared bat (*Nyctophilus corbeni*). [image] [online] Available from: https://images.ala.org.au/image/details?imageId=2c438bfa-583a-4585-846c-135199ce39d6. [19 September 2019].

Table 7.4 Species resilience questionnaire – Corben's long-eared bat (*Nyctophilus corbeni*)

Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes **(2)** ▪ Unlikely to change as a result of the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Key threats to this species include: ▪ Habitat loss and/or fragmentation ▪ Destruction of roosting sites and foraging habitat through fire ▪ Overgrazing and forestry activity ▪ Predation by feral species and competition for tree hollows ▪ Exposure to agrichemicals Project works which require clearing and the of habitat and subsequent fragmentation of areas associated with the project. This is likely to contribute to threatening processes for this species.	2
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ▪ Decline or shift from current location (3) ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Habitat specific to breeding is not likely to be impacted as a result of project related activities.	0
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ▪ Decline or shift from current location **(2)** ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Non breeding habitat for this species will be reduced in size as a result of project related activities	2
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Unlikely to change **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Breeding habitat components will remain un-changes as a result of the project activities	0

Item	Question	Criteria	Species response	Score
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ▪ Expected to decrease or habitat components required for non-breeding unknown **(2)** ▪ Unlikely to change **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Non-breeding habitat components will remain un-changes as a result of the project activities	0
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	Low ability to disperse **(2)** ▪ Mobile, but dispersal is sex-biased (only one sex disperses) **(1)** ▪ Very mobile, both sexes disperse **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This is a highly vagile species and has a high potential to colonize new areas of habitat.	0
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	▪ Species migratory habitats will be adversely affected **(2)** ▪ Species migratory habitats will not be adversely affected **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Species migratory patterns are not likely to be altered in response to the project activities	0
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(2)** ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species is highly vagile and has flexible strategies to cope with variable resource availability. This species hunts over a vast area	0
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ▪ Once per year or less **(2)** ▪ More than once per year **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Several offspring are produced during a defined period each year	2

Item	Question	Criteria	Species response	Score
Q10.	Food resources: Are important food resources for this species expected to change?	▪ Primary food source(s) are expected to be negatively impacted by projected changes **(2)** ▪ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species feeds on a variety of invertebrates and forages over a wide area. Important food resources are not expected to change as a result of the project.	0
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: ▪ Is expected to increase as a result of the projected changes **(2)** ▪ Is not expected to be impacted by the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Increased levels of predation and the species vulnerability is not expected to be impacted by the project activities	0
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	▪ Disease prevalence is expected increase with projected changes **(2)** ▪ No known effects of expected changes on disease prevalence (0) ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The nature of works is unlikely to introduce disease that may cause species decline	0
Q13.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes **(2)** ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	There are no major competitors recognised as a key threating process to this species. No change is expected.	0
Total score				6
Species resilience				**Moderate**

7.5 Dunmall's snake (*Furina dunmalli*)

7.5.1 Status

EPBC Act – Vulnerable

BC Act – Not listed

7.5.2 Biology and ecology

Characteristics

Dunmall's snake (*Furina dunmalli*) is a small to medium-sized, venomous (family Elapidae), snake that typically grows to a length of up to 75 cm. It has a uniform dark grey-brown colour on the top of the body, which fades to white at its lower flanks and has 21 rows on the mid-section. Most of the scales near the upper lip exhibit pale blotches. The head is large and distinct from the neck (DES 2019).

No image available.

Known distribution

Dunmall's snake is endemic to Australia and inhabits areas near the Queensland border within the Brigalow Belt South bioregion to the Nandewar bioregion in NSW (refer Figure 7.5). In Queensland, the snake is often found in areas 200 to 500 m above sea level with recorded sightings in Oakey and Inglewood. In NSW, the species is predominantly found in the northeast inland region (DotEE 2019).

Figure 7.5 Distribution range of the Dunmall's snake

Source: ALA (2019)

Biology and reproduction

Dunmall's snake are known to eat small lizards such as skinks and geckos. Analysis of the gut contents of this species yielded the remains of Tree skink (*Egernia striolata*). Limited knowledge is available on the snake's life cycle or reproductive behaviour, however, it is known that the species lays eggs rather than give birth to live young (DotEE 2019).

7.5.3 Habitat

Given the rarity, and difficulty of detecting Dunmall's snake, all suitable habitats (remnant or non-remnant vegetation) that are coincident with the known locations of the species are considered important habitats. Dunmall's snake has been found in a broad range of habitats, including:

- Forests and woodlands on black alluvial cracking clay and clay loams dominated by Brigalow (*Acacia harpophylla*), other Wattles (*A. burowii, A. deanii, A. leioclyx*), native Cypress (*Callitris* spp.) or Bull-oak (*Allocasuarina luehmannii*)
- Various Spotted gum (*Corymbia citriodora*), Ironbark (*Eucalyptus crebra* and *E. melanophloia*), White cypress pine (*Callitris glaucophylla*) and Bull-oak open forest and woodland associations on sandstone derived soils
- The edge of dry vine scrub near Tarong Power Station, Queensland, and hard ironstone country (Queensland RE Land Zone 7) at Lake Broadwater near Dalby, Queensland.

There is a paucity of information related to ecological requirements of this species, however it has been observed sheltering under fallen timber and ground debris, and is known to utilise cracks in alluvial clay soils (DES 2019; DotEE 2019).

7.5.4 Threatening processes

The following have been identified as potentially threatening processes to Dunmall's snake:

- Habitat loss and fragmentation due to land clearing in core areas of the Darling Downs
- Predation by feral animals such as foxes, cats and pigs
- Inappropriate road side management (DES 2019).

7.5.5 Species resilience

Determination of species resilience is presented in Table 7.5.

7.5.6 References

Atlas of Living Australia (2019). Furina dunmalli. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:9ba2edaa-574b-4c18-8503-d0b658b16cc4 [Accessed 2 September 2019].

Department of Environment and Energy (2019). Furina dunmalli (Dunmall's Snake) in Species Profile and Threats Database. Australian Government. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=59254 [Accessed 2 September 2019].

Department of Environment and Science (2019). Dunmall's snake. Queensland Government. Available from: https://www.ehp.qld.gov.au/wildlife/animals-az/dunmalls_snake.html [Accessed 2 September 2019].

Wilson, S (n.d). Dunmall's snake. In. Shy snake is hard to spot. ABC Wide Bay Publication. Available from: http://www.abc.net.au/local/stories/2009/04/21/2548064.htm [Accessed 12 September 2019].

Table 7.5 Species resilience questionnaire – Dunmall's snake (*Furina dunmalli*)

Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes **(2)** ▪ Unlikely to change as a result of the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Key threats to this species include: ▪ Habitat loss and fragmentation due to land clearing in core areas of the Darling Downs ▪ Predation by feral animals such as foxes, cats and pigs ▪ Inappropriate road side management Project works which require clearing and the removal have potential to significantly impact upon this species and contribute to the threatening processes identified above.	2
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ▪ Decline or shift from current location (3) ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	There is potential for vegetation on black cracking clays to be impacted. This is known to support the species and breeding habitat	2
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ▪ Decline or shift from current location **(2)** ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	There is potential for vegetation on black cracking clays to be impacted. This is known to support the species	2
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Unlikely to change **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Breeding habitat components are not expected to change as a result of project activities.	0

Item	Question	Criteria	Species response	Score
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ▪ Expected to decrease or habitat components required for non-breeding unknown **(2)** ▪ Unlikely to change **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Non-breeding habitat components are not expected to change as a result of project activities.	0
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	Low ability to disperse **(2)** ▪ Mobile, but dispersal is sex-biased (only one sex disperses) **(1)** ▪ Very mobile, both sexes disperse **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species has a poor dispersal ability and has limited ability to colonize new areas of habitat. and has a high potential to colonize new areas of habitat.	2
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	▪ Species migratory habitats will be adversely affected **(2)** ▪ Species migratory habitats will not be adversely affected **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Species migratory patterns are not likely to be altered in response to the project activities	0
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(2)** ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species has flexible feeding mechanisms and life history attributes to allow it to cope with resource fluctuations	0
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ▪ Once per year or less **(2)** ▪ More than once per year **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	It is speculated that only a single clutch of eggs is produced each year	2

Item	Question	Criteria	Species response	Score
Q10.	Food resources: Are important food resources for this species expected to change?	▪ Primary food source(s) are expected to be negatively impacted by projected changes **(2)** ▪ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species feeds on a variety of common lizards. Important food resources are not expected to change as a result of the project.	0
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: ▪ Is expected to increase as a result of the projected changes **(2)** ▪ Is not expected to be impacted by the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Increased levels of predation and the species vulnerability is not expected to be impacted by the project activities	0
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	▪ Disease prevalence is expected increase with projected changes **(2)** ▪ No known effects of expected changes on disease prevalence (0) ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The nature of works is unlikely to introduce disease that may cause species decline	0
Q13.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes **(2)** ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	There are no major competitors recognised as a key threating process to this species. No change is expected.	0
Total score				10
Species resilience				**Moderate**

7.6 Five-clawed worm-skink (*Anomalopus mackayi*)

7.6.1 Status

EPBC Act – Vulnerable

BC Act – Endangered

7.6.2 Biology and ecology

Characteristics

The Five-clawed worm-skink (*Anomalopus mackayi*), is a burrowing skink, which is characterised by three fingers and two toes. This species typically grows to 27 cm long. It has smooth scales with an overall greyish-brown upper body, with dark spots in longitudinal rows. Its ventral surface is yellow-green with dark flecking. In the southern region of its range, this species is unpatterned, while in the north, it has longitudinal rows of dark spots on the dorsal and lateral surfaces (Cogger 2000; DotEE 2019).

No image available.

Known distribution

The known distribution of the Long-legged worm-skink is patchy in North West Sloped and Plains of north-east NSW and southeastern Queensland (refer Figure 7.6). In southeastern Queensland, the species' known distribution is on the upper Condamine River floodplain, from Warwick in the south, to the Jimbour region in the north, and bordered by the western edge of the granite belt (Brigalow Belt Reptiles Workshop 2010; DotEE 2019, OEH 2019).

Figure 7.6 Distribution range of the Five-clawed worm-skink

Source: ALA (2019)

Biology and reproduction

Very little is known about the Five-clawed worm-skink's reproduction and diet. However, it is believed to feed on arthropods, such as white ants and captive specimens have been recorded eating mealworms (Cogger et al. 1983; Shea et al. 1987).

Long-legged worm-skinks lay up to three eggs per clutch during Spring (Shea et al. 1987; Wilson and Knowles 1988; Ehmann 1992).

7.6.3 Habitat

The Five-clawed worm-skink is known to occur in both remnant and non-remnant woodlands and grasslands, and in areas modified by agriculture and other human activities. It is typically found under timber, leaf litter and other debris. It is also known to inhabit rotting tree base cavities, logs and tussock bases. This species has been found sheltering under artificial materials lying flat on the ground, such as discarded railway sleepers, sheet metal and hay bales. On the Darling Downs, the species occurs in Bluegrass (*Dichanthium sericeum*) and/or Mitchell Grass (*Astrebla* spp.) dominated grasslands, or mixed grasslands dominated by other grass species (Brigalow Belt Reptiles Workshop 2010; DotEE 2019, OEH 2019).

7.6.4 Threatening processes

The following have been identified as potentially threatening processes to the Five-clawed worm-skink:

- Land clearing for agriculture has been particularly severe within the Five-clawed worm-skink’s range
- Overgrazing compacts soil making it difficult for the species to find suitable shelter
- Removal of logs and timber also reduces soil humidity and the amount of shelter available for the species. Agricultural chemicals may poison and pollute the soil which may adversely affect the species
- Predation by feral species, such as cats and foxes, is another threat facing much of Australia's native wildlife including the Long-legged worm-skink (Brigalow Belt Reptiles Workshop 2010; NSW NPWS 1999).

7.6.5 Species resilience

Determination of species resilience is presented in Table 7.6.

7.6.6 References

Atlas of Living Australia (2019). *Anomalopus mackayi*. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:bcbb3f69-0f90-4b6d-a062-218439a61a51 [Accessed 13 September 2019].

Brigalow Belt Reptiles Workshop (2010). Proceedings from the workshop for the nine listed reptiles of the Brigalow Belt bioregions. 18-19 August. Brisbane: Queensland Herbarium.

Cogger H.G. (2000). *Reptiles and Amphibians of Australia*, (6th edition) Ralph Curtis Books, NSW

Department of the Environment and Energy (2019). *Anomalopus mackayi* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=25934 [Accessed 13 September 2019].

Dolley, C (n.d.). Photograph: Long-legged worm-skink, Department of National Parks, Sport and Racing, (Image) [Online] Available from: https://www.ehp.qld.gov.au/wildlife/animals-az/longlegged_wormskink.html [Accessed 12 September 2019].

Ehmann, H. (1992). Encyclopaedia of Australian Animals: Reptiles. Angus and Robertson: Sydney

Office of Environment and Heritage. 2019. Threatened biodiversity profile search - Five-clawed Worm-skink – profile. Available at: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10055 [Viewed on 18 September 2019]

Table 7.6 Species resilience questionnaire – Five-clawed worm-skink (*Anomalopus mackayi*)

Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes **(2)** ▪ Unlikely to change as a result of the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Key threats to this species include: ▪ Land clearing for agriculture has been particularly severe within the Long-legged worm-skink's range ▪ Overgrazing compacts soil making it difficult for the species to find suitable shelter ▪ Removal of logs and timber also reduces soil humidity and the amount of shelter available for the species. Agricultural chemicals may poison and pollute the soil which may adversely affect the species ▪ Predation by feral species, such as cats and foxes, is another threat facing much of Australia's native wildlife including the Long-legged worm-skink Project works which require clearing and the removal surface debris has the potential to significantly impact upon this species. This is likely to increase the threatening processes for this species within the vicinity of the project	2
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ▪ Decline or shift from current location (3) ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	It is an anticipated that breeding habitat will stay the same and in approximately the same location	0
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ▪ Decline or shift from current location **(2)** ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Areas of non-breeding habitat will be removed as part of the proposed works	2

Item	Question	Criteria	Species response	Score
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Unlikely to change **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Breeding habitat components will remain unchanged in response to project activities	0
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ▪ Expected to decrease or habitat components required for non-breeding unknown **(2)** ▪ Unlikely to change **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Non-breeding habitat components will remain unchanged in response to project activities	0
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	Low ability to disperse **(2)** ▪ Mobile, but dispersal is sex-biased (only one sex disperses) **(1)** ▪ Very mobile, both sexes disperse **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species has a poor dispersal ability and has limited ability to colonize new areas of habitat. and has a high potential to colonize new areas of habitat.	2
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	▪ Species migratory habitats will be adversely affected **(2)** ▪ Species migratory habitats will not be adversely affected **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Species migratory patterns are not likely to be altered in response to the project activities	0

Item	Question	Criteria	Species response	Score
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(2)** ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species* ***(120)***	This species has flexible feeding mechanisms and life history attributes to allow it to cope with resource fluctuations	0
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ▪ Once per year or less **(2)** ▪ More than once per year **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species* ***(120)***	It is speculated that only a single clutch of eggs is produced each year	2
Q10.	Food resources: Are important food resources for this species expected to change?	▪ Primary food source(s) are expected to be negatively impacted by projected changes **(2)** ▪ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species* ***(120)***	This species feeds on a variety of common lizards. Important food resources are not expected to change as a result of the project.	0
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: ▪ Is expected to increase as a result of the projected changes **(2)** ▪ Is not expected to be impacted by the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species* ***(120)***	Increased levels of predation and the species vulnerability is not expected to be impacted by the project activities	0

Item	Question	Criteria	Species response	Score
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	- Disease prevalence is expected increase with projected changes **(2)** - No known effects of expected changes on disease prevalence (0) - *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species* ***(120)***	The nature of works is unlikely to introduce disease that may cause species decline	0
Q13.	Competitors: Are populations of important competing species expected to change?	- Major competitor species are expected to be positively impacted by projected changes **(2)** - Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)** - *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species* ***(120)***	There are no major competitors recognised as a key threating process to this species. No change is expected.	0
Total score				8
Species resilience				**Moderate**

NSW National Parks and Wildlife Service (1999). *Five-clawed Worm-skink - Threatened Species Information*. Available from: http://www.environment.nsw.gov.au/resources/nature/tsprofileFiveclawedWormskink.pdf

Shea, G.M., Millgate M. and Peck S. (1987). A range extension for the rare skink *Anomalopus mackayi. Herpetofauna.* 17 (2):16-19.

Wilson, S.K. and Knowles, D.G. (1988). Australia's Reptiles A Photographic Reference to the Terrestrial Reptiles of Australia. Collins: Sydney.

7.7 Koala (*Phascolarctos cinereus*)

7.7.1 Status

EPBC Act – Vulnerable

BC Act – Vulnerable

7.7.2 Biology and ecology

Characteristics

The Koala (*Phascolarctos cinereus*) is an arboreal marsupial, with a stocky body, large rounded ears, sharp claws and has grey-coloured fur (refer Photograph 7.5). This species displays sexual dimorphism (males generally are larger than females), with male Koalas weighing approximately 6.5 kg (DotEE 2019).

Photograph 7.5 Koala (*Phascolarctos cinereus*)

Source: Walker (2017)

Known distribution

The Koala is distributed along the east coast of Australia extending from Queensland to NSW (refer Figure 7.7). In Queensland, the Koala's distribution extends across several bioregions, encompassing a great diversity of habitats with the greatest concentration on southeast Queensland. In NSW, the species occurs mostly in central and north coasts with populations known to inhabit the area west of the Great Dividing Range (DES 2019; OEH 2019).

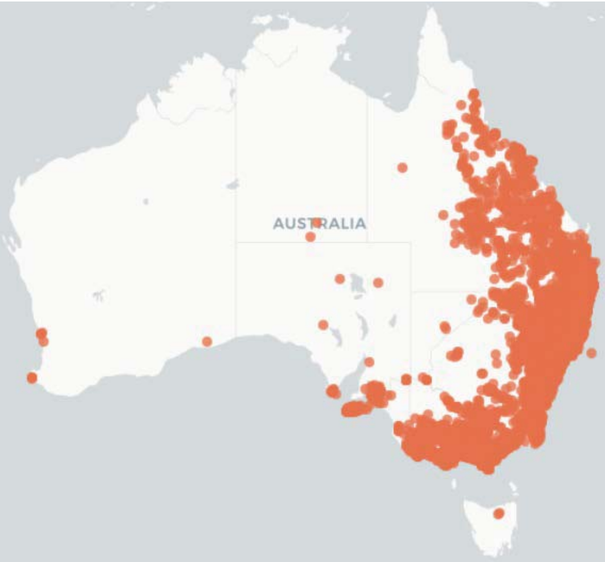


Figure 7.7 **Distribution range of Koala**

Source: ALA (2019)

Biology and reproduction

The Koala is a leaf-eating specialist feeding primarily during dawn, dusk or during the night. Its diet is restricted mainly to foliage of Eucalyptus spp.; however, it may also consume foliage of related genera, including *Corymbia* spp., *Angophora* spp. and *Lophostemon* spp. The Koala may, at times, supplement its diet with other species, including Leptospermum spp. and Melaleuca spp. (Crowther et al. 2013, Martin and Handasyde 1999; Moore and Foley 2000).

Female Koalas can potentially produce one offspring each year with births occurring between October and May. The newly-born Koala lives in its mother's pouch for six to eight months and, after leaving the pouch, remain dependent on the mother, riding on her back. Young Koalas are independent from about 12 months of age (DotEE 2019).

7.7.3 Habitat

Koala habitat can be broadly defined as any environment containing Koala food tree species (*Eucalyptus* spp., *Corymbia* spp., *Angophora* spp. and *Lophostemon* spp.) or shelter trees. Preferred food and shelter trees are naturally abundant on fertile clayey soils (DotEE 2019).

Along the Great Dividing Range and the coastal belt throughout the species' range, Koalas inhabit moist forests and woodlands mostly dominated by Eucalyptus species. Koalas are also known to occur in highly modified (e.g. urbanised) or regenerating native vegetation communities (DotEE 2019).

7.7.4 Threatening processes

The following have been identified as potentially threatening processes to the Koala:

- Habitat loss, modification or fragmentation as a result of urbanisation
- Secondary threats such as predation by domestic dogs, vehicle strikes and stress
- *Chlamydia* which reduces the life expectancy of the species (OEH 2019; DES 2019).

7.7.5 Species resilience

Determination of species resilience is presented in Table 7.7.

Table 7.7 Species resilience questionnaire – Koala (*Phascolarctos cinereus*)

Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes **(2)** ▪ Unlikely to change as a result of the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Key threats to this species include: ▪ Habitat loss, modification or fragmentation as a result of urbanisation ▪ Secondary threats such as predation by domestic dogs, vehicle strikes and stress ▪ *Chlamydia* which reduces the life expectancy of the species Project works which require clearing and the removal have potential which will further fragment existing area of habitat. This will contribute the pressures associated with threatening processes for Koalas in this area.	2
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ▪ Decline or shift from current location (3) ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	There is no specific breeding habit used by Koala as such there will be no removal associated with the project activities.	0
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ▪ Decline or shift from current location **(2)** ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The project will result in removal of Koala habitat and a decline in its current extent.	2
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Unlikely to change **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Breeding habitat components will remain unchanged	0

Item	Question	Criteria	Species response	Score
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ■ Expected to decrease or habitat components required for non-breeding unknown **(2)** ■ Unlikely to change **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Non-breeding habitat components are considered to remain largely unchanged by the project activities	0
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	Low ability to disperse **(2)** ■ Mobile, but dispersal is sex-biased (only one sex disperses) **(1)** ■ Very mobile, both sexes disperse **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The Koala has a defined territory. With this territory the animal is able to disperse. There is gender bias dispersal in this species	1
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	■ Species migratory habitats will be adversely affected **(2)** ■ Species migratory habitats will not be adversely affected **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Species migratory patterns are not likely to be altered in response to the project activities	0
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ■ Limited flexible strategies to cope with variable resources across multiple years **(2)** ■ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The koala has limited strategies to cope with resource fluctuations	2
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ■ Once per year or less **(2)** ■ More than once per year **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Only a single offspring is produced each year	2

Item	Question	Criteria	Species response	Score
Q10.	Food resources: Are important food resources for this species expected to change?	▪ Primary food source(s) are expected to be negatively impacted by projected changes **(2)** ▪ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species feeds on a restricted range of eucalyptus species. The project may have important implications upon food availability for this species.	2
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: ▪ Is expected to increase as a result of the projected changes **(2)** ▪ Is not expected to be impacted by the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Increased levels of predation and the species vulnerability is not expected to be impacted by the project activities	0
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	▪ Disease prevalence is expected increase with projected changes **(2)** ▪ No known effects of expected changes on disease prevalence (0) ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Stress associated with the project activities may contribute towards disease in this species	2
Q13.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes **(2)** ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	There are no major competitors recognised as a key threating process to this species. No change is expected.	0
Total score				13
Species resilience				**Moderate**

7.7.6 References

Atlas of Living Australia. (2019). Phascolarctos cinereus. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:e9d6fbbd-1505-4073-990a-dc66c930dad6 [Accessed 18 September 2019].

Crowther, M., D. Lunney, J. Lemon, E. Stalenberg, R. Wheeler, G. Madani, K. Ross and M. Ellis. (2013). Climate-mediated habitat selection in an arboreal folivore. Ecography. 36:001-008.

Department of Environment and Energy (2019). Phascolarctos cinereus (Koala) Species Profile and Threats Database. Australian Government. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=85104 [Accessed 18 September 2019].

Department of Environment and Science (2019). Koala facts. Queensland Government. Available from: https://www.ehp.qld.gov.au/wildlife/koalas/koala-ecology.html [Accessed 13 September 2019].

Martin, R. and K. Handasyde. (1999). The Koala: Natural history, conservation and management. Sydney, NSW: UNSW Press.

Moore, B.D. and W.J. Foley. (2000). A review of feeding and diet selection in koalas (Phascolarctos cinereus). Australian Journal of Zoology. 48:317-333.

Office of Environment and Heritage (2019). Koala - Profile. New South Wales Government. Available from: https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10616 [Accessed 18 September 2019].

Walker, B. (2017). *Phascolarctos cinereus* - Koala. [image] [online] Available from: https://images.ala.org.au/image/details?imageId=72044d32-05fc-47ef-96fd-cd5968d0ed03 [16 September 2019].

7.8 Large-eared pied bat (*Chalinolobus dwyeri*)

7.8.1 Status

EPBC Act – Vulnerable

BC Act – Vulnerable

7.8.2 Biology and ecology

Characteristics

The Large-eared pied bat (*Chalinolobus dwyeri*) is a medium-sized insectivorous bat measuring approximately 100 mm in length, and weighing 7 to 12 g. This species exhibits a shiny black coat, with a white stripe on the flank (underside) of each wing. The ears are large and the facial lobes are located on the lower lip, between the corner of the mouth and the bottom of the ear (refer Photograph 7.6). Its short, broad wings suggest that this species flies slowly, and with considerable manoeuvrability (DERM 2011; DotEE 2019; Hoye and Dwyer 1995; Ryan 1966).

Photograph 7.6 Large-eared pied bat (*Chalinolobus dwyeri*)

Source: Musser (2017)

Known distribution

The former and current distribution of the Large-eared pied bat is poorly known. Records for current distribution exist from Shoalwater Bay and inland to Carnavon in Queensland, through to Ulladulla, in NSW (refer Figure 7.8). It is thought that this species is uncommon and has a patchy distribution (DotEE 2019).

Figure 7.8 Distribution range of the Large-eared pied bat

Source: ALA (2019)

Biology and reproduction

The Large-eared pied bat feeds on insects flying at 6 to 10 m off the ground and along creek lines. It is unknown if it targets particular groups of insects (Curtis et al. 2012; DERM 2011).

Females can give birth at one year of age, and males also appear capable of breeding at this age. Mating appears to occur in early winter. A nursery colony is typically established in September by both adult females and males, with the majority of adult males leaving by the time the young are born in early summer. Females are known to give birth to one or two young per year. By the end of March the juveniles have left the roost. The adult females leave the roost after the juveniles, and the site is abandoned during the winter months. Life expectancy and natural mortality have not been determined (DotEE 2011; Dwyer 1966; Hoye and Dwyer 1995).

7.8.3 Habitat

Available roosts are unevenly distributed throughout the landscape. Large-eared pied bats require a combination of sandstone cliffs/escarpments to provide roosting habitat that is adjacent to higher fertility sites (particularly box gum woodlands or river/rainforest corridors which are used for foraging) (DotEE 2019).

Large-eared pied bats have been observed in disused mine shafts, caves, overhangs and disused Fairy martin (*Hirundo ariel*) nests for shelter and to raise young. This species possibly also roosts in tree hollows, within dry and wet sclerophyll forest, Cyprus-pine dominated forest, tall open eucalypt forest with a rainforest sub-canopy, sub-alpine woodland, Brigalow and sandstone outcrop country. In southeast Queensland, the species has primarily been recorded from higher altitude, among moist tall open forest adjacent to rainforest (DotEE 2019; Hoye and Dwyer 1995; Schulz 1998).

7.8.4 Threatening processes

The following have been identified as potentially threatening processes to the Large-eared pied bat:

- Disturbance and damage to primary nursery sites by animals (particularly goats) and humans (Hoye 2005; Duncan et al. 1999; TSSC 2012)
- Populations can be easily displaced as they roost in disused mines which often become active if commodity prices make them economical or they can be filled for safety reasons (Hoye 2005; Duncan et al. 1999; TSSC 2012).

7.8.5 Species resilience

Determination of species resilience is presented in Table 7.8.

7.8.6 References

Atlas of Living Australia (2019). *Chalinolobus dwyeri*. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:cddd224d-40ed-49d9-bb88-dcbfe064a35e#gallery [Accessed 17 September 2019].

Curtis, L.K., Dennis, A.J., McDonald, K.R., Kyne, P.M. and Debus, S.J.S. (2012). *Queensland's Threatened Animals* CSIRO Publishing, Collingwood, Victoria, Australia

Department of Environment and Resource Management (2011). National recovery plan for the Large-eared pied bat *Chalinolobus dwyeri*. Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Department of the Environment and Energy (2019). *Chalinolobus dwyeri* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=183 [Accessed 17 September 2019].

Table 7.8 **Species resilience questionnaire – Large-eared pied bat (*Chalinolobus dwyeri*)**

Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes **(2)** ▪ Unlikely to change as a result of the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Key threats to this species include: ▪ Disturbance and damage to primary nursery sites by animals (particularly goats) and humans ▪ Populations can be easily displaced as they roost in disused mines which often become active if commodity prices make them economical or they can be filled for safety reasons Project works which require clearing are unlikely to increase threatening processes for this species	0
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ▪ Decline or shift from current location (3) ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	There are no known nurseries for this species within the proposed disturbance area. There are no impacts expected upon breeding habitat.	0
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ▪ Decline or shift from current location **(2)** ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species forages over an extensive area during its nocturnal activity period. Foraging habitat is likely to be reduced in size as as a result of project related activities.	2
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Unlikely to change **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	No breeding habitat components will be changes as part of the project related activities	0

Item	Question	Criteria	Species response	Score
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ▪ Expected to decrease or habitat components required for non-breeding unknown **(2)** ▪ Unlikely to change **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Non-breeding habitat components will remain largely unchanged as a result of the project activities	0
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	Low ability to disperse **(2)** ▪ Mobile, but dispersal is sex-biased (only one sex disperses) **(1)** ▪ Very mobile, both sexes disperse **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This is a highly vagile species and has a high potential to colonize new areas of habitat.	0
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	▪ Species migratory habitats will be adversely affected **(2)** ▪ Species migratory habitats will not be adversely affected **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Species migratory patterns are not likely to be altered in response to the project activities	0
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(2)** ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species is highly vagile and has flexible strategies to cope with variable resource availability	0
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ▪ Once per year or less **(2)** ▪ More than once per year **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Only a single offspring is produced each year	2

Item	Question	Criteria	Species response	Score
Q10.	Food resources: Are important food resources for this species expected to change?	▪ Primary food source(s) are expected to be negatively impacted by projected changes **(2)** ▪ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species feeds on a variety of invertebrates and forages over a wide area. Important food resources are not expected to change as a result of the project.	0
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: ▪ Is expected to increase as a result of the projected changes **(2)** ▪ Is not expected to be impacted by the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Increased levels of predation and the species vulnerability is not expected to be impacted by the project activities	0
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	▪ Disease prevalence is expected increase with projected changes **(2)** ▪ No known effects of expected changes on disease prevalence (0) ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The nature of works is unlikely to introduce disease that may cause species decline	0
Q13.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes **(2)** ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	There are no major competitors recognised as a key threating process to this species. No change is expected.	0
Total score				4
Species resilience				**Moderate**

Duncan, A., Baker, G.B and Montgomery, N. 1999, *The Action Plan for Australian Bats.* [Online]. Canberra: Environment Australia. Available from: http://www.environment.gov.au/biodiversity/threatened/publications/action/bats/index.html. [Accessed 17 September 2019].

Dwyer, P.D. (1966). Observations on Chalinolobus dwyeri (Chiroptera: Vespertilionidae) Australia. Journal of Mammalogy. 47:716-718.

Hoye, G.A. and Dwyer P.D. (1995). Large-eared pied bat *Chalinolobus dwyeri*. **In:** Stahan, R, ed. *The Mammals of Australia*. Page(s) 510-511. Chatswood, NSW: Reed Books.

Hoye, G.A. (2005). *Recovery plan for the large-eared pied bat Chalinolobus dwyeri*. Fly By Night Bat Surveys Pty Ltd. Brisbane: Queensland Parks and Wildlife Service.

Musser, A. (2017). Large-eared pied bat (*Chalinolobus dwyeri*). [image] [online] Available from: **https://images.ala.org.au/image/details?imageId=d05ddeaf-7807-489b-9269-50f79951560d**. [16 September 2019].

Ryan, R.M. (1966). A new and imperfectly known Australian Chalinolobus and the taxonomic status of African Glauconycteris. *Journal of Mammalogy*. 47:86-91.

Schulz, M. (1998). Bats and other fauna in disused Fairy Martin Hirundo arial nests. *Emu*. 98:184-191.

Threatened Species Scientific Committee (2012). *Commonwealth Listing Advice on* Chalinolobus dwyeri *(Large-eared Pied Bat)*. Department of Sustainability, Environment, Water, Population and Communities. Canberra, ACT: Department of Sustainability, Environment, Water, Population and Communities. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/183-listing-advice.pdf. In effect under the EPBC Act from 29 June 2012.

7.9 Murray cod (*Maccullochella peelii*)

7.9.1 Status

EPBC Act – Vulnerable

BC Act – Not listed

7.9.2 Biology and ecology

Characteristics

The Murray cod (*Maccullochella peelii*) is the largest freshwater species of fish in Australia, measuring up to 1.8 m in length and weighing about 10 kg although some records indicate the species may reach over 100 kg in weight. The Murray cod has a broad head, rounded snout, equal length jaws and has a concaved facial profile. The light olive to dark green scales of the fish has mottled pattern, with a white ventral colouration. The pectoral fins of the fish are rounded and large with soft dorsal, anal and caudal fins with distinctive red or white edging (DotEE 2019) (refer Photograph 7.7).

Photograph 7.7 Murray cod (*Maccullochella peelii*)

Source: flagstaffotos (2006)

Known distribution

The Murray cod was once a widespread species and abundant in the lower and mid reaches of the Murray-Darling Basin between Queensland and South Australia (refer Figure 7.9). However, the distribution of the species has now reduced to several bioregions between Queensland and Victoria, including the Brigalow Belt South Bioregion (National Murray Cod Recovery Team 2010, DotEE 2019).

Figure 7.9 Distribution range of Murray cod

Source: ALA (2019)

Biology and reproduction

Due to the size of the Murray cod, it is considered the apex predator of the Murray-Darling river system and known to ambush its prey. The demersal species is known to hunt from sunset to sunrise, feeding on spiny crayfish and shrimp as well as reptiles and other fish species including cod (DotEE 2019).

The Murray cod has relatively low fertility compared to many other freshwater fish with the species generally reaching sexual maturity, which is heavily dependent on size, at 5 years of age. Male Murray cod, who are known to guard and fan the eggs during incubation, mature at a larger size than females with the species breeding as a pair. A female cod weighing 3 kg can produce up to 10,000 eggs often laid in logs or snags after developing them through winter until spawning, which is triggered by an increase in temperature and day length (DotEE 2019).

Upon hatching larvae tend to remain clustered in their nest for up to 11 days with the male continually providing protection before the larvae leave the nest to drift downstream and feed on zooplankton as well as aquatic insects (DotEE 2019).

7.9.3 Habitat

The habitat of the species is diverse, ranging from clear rocky streams to slow-flowing, turbid lowland rivers or billabongs where the fish is found frequently in the main channel. Due to the species preferred breeding environment, it is often found in streams containing large rock, snags, overhanging vegetation, stumps or other woody structures (DotEE 2019).

The species is known to take long distance journeys prior to spawning travelling up to several hundred kilometres upstream despite their naturally sedentary nature (Koehn et al. 2009).

7.9.4 Threatening processes

The following have been identified as potentially threatening processes to the Murray cod:

- Impoundment of streams and altered water flow
- Loss of riparian vegetation
- Habitat removal, modification and degradation (DotEE 2019).

7.9.5 Species resilience

Determination of species resilience is presented in Table 7.9.

7.9.6 References

Atlas of Living Australia. (2019). Maccullochella peelii. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:54e10f17-f08c-4f93-b576-681f361ffe56 [Accessed 17 September 2019].

Department of Environment and Energy. (2019). Maccullochella peelii (Murray Cod) Species Profile and Threats Database. Australian Government. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=66633 [Accessed 17 September 2019].

Flagstaffotos. (2006). *Maccullochella peelii* - Murray Cod. [image] [online] Available from: https://commons.wikimedia.org/wiki/File:Murray_cod_melb_aquarium.jpg. [16 September 2019].

Koehn J.D., J.A. McKenzie, D.J. O'Mahony, S.J. Nicol, J.P. O'Connor and W.G. O'Connor. (2009). Movements of Murray cod (Maccullochella peelii peelii) in a large Australian lowland river. Ecology of Freshwater Fish. 18:594-602. John Wiley and Sons A/S.

Murray Darling Basin Authority. (2007). Native Species – Murray Cod (Maccullochella peelii peelii). Available from: https://www.mdba.gov.au/sites/default/files/archived/mdbc-NFS-reports/2202_factsheet_native_murray_cod.pdf [Accessed 18 September 2019].

National Murray Cod Recovery Team (2010). National Recovery Plan for the Murray Cod Maccullochella peelii peelii. Department of Sustainability and Environment, Melbourne. Available from: http://www.environment.gov.au/resource/national-recovery-plan-murray-cod-maccullochella-peelii-peelii [Accessed 18 September 2019].

Table 7.9 Species resilience questionnaire – Murray cod (*Maccullochella peelii*)

Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes **(2)** ▪ Unlikely to change as a result of the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Key threats to this species include: ▪ Impoundment of streams and altered water flow ▪ Loss of riparian vegetation ▪ Habitat removal, modification and degradation (DotEE 2019). Project works which require clearing are unlikely to increase threatening processes for this species	0
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ▪ Decline or shift from current location (3) ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Area used for breeding habitat expected to: Stay the same and in approximately the same location	0
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ▪ Decline or shift from current location **(2)** ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Area used for non-breeding habitat expected to Stay the same and in approximately the same location	0
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Unlikely to change **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	No breeding habitat components will be changes as part of the project related activities	0

Item	Question	Criteria	Species response	Score
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ▪ Expected to decrease or habitat components required for non-breeding unknown **(2)** ▪ Unlikely to change **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Non-breeding habitat components will remain largely unchanged as a result of the project activities	0
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	Low ability to disperse **(2)** ▪ Mobile, but dispersal is sex-biased (only one sex disperses) **(1)** ▪ Very mobile, both sexes disperse **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This is aquatic and has a low ability to disperse	2
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	▪ Species migratory habitats will be adversely affected **(2)** ▪ Species migratory habitats will not be adversely affected **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Species migratory patterns are not likely to be altered in response to the project activities	0
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(2)** ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species is limited flexible strategies to cope with variable resource availability	2
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ▪ Once per year or less **(2)** ▪ More than once per year **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Only a brood single offspring is produced each year	2

Item	Question	Criteria	Species response	Score
Q10.	Food resources: Are important food resources for this species expected to change?	- Primary food source(s) are expected to be negatively impacted by projected changes **(2)** - Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes **(0)** - *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species feeds on a variety of invertebrates and vertebrates. Important food resources are not expected to change as a result of the project.	0
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: - Is expected to increase as a result of the projected changes **(2)** - Is not expected to be impacted by the projected changes **(0)** - *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Increased levels of predation and the species vulnerability is not expected to be impacted by the project activities	0
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	- Disease prevalence is expected increase with projected changes **(2)** - No known effects of expected changes on disease prevalence (0) - *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The nature of works is unlikely to introduce disease that may cause species decline	0
Q13.	Competitors: Are populations of important competing species expected to change?	- Major competitor species are expected to be positively impacted by projected changes **(2)** - Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)** - *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	There are no major competitors recognised as a key threating process to this species. No change is expected.	0
Total score				6
Species resilience				**Moderate**

7.10 Painted honeyeater (*Grantiella picta*)

7.10.1 Status

EPBC Act – Vulnerable

BC Act – Vulnerable

7.10.2 Biology and ecology

Characteristics

Painted honeyeater (*Grantiella picta*) is a medium honeyeater, growing to a length of 14 to 15 cm in size. The Painted honeyeater weights around 20 to 25 g and has a black head and back, and bright yellow on the wings and upper tail and a bright pink bill (refer Photograph 7.8). The male is distinguished by white underparts with black streaks on flanks (above legs). The females are slightly smaller than the males and identified by brownish-black colouring with white underparts. Juveniles are browner and have a greyish coloured bill. The Painted honeyeater is known to use the same nest sites each season and are generally seen in pairs or singles, rarely in small flocks of up to six birds (DES 2019; Higgins et al*.* 2001; Simpson and Day 2004).

Photograph 7.8 Painted honeyeater (*Grantiella picta*)

Source: Knight (2009)

Known distribution

The Painted honeyeater is endemic to Australia and its distribution over summer and spring stretches from inland central Victoria through scattered parts of NSW, the ACT and southern Queensland (refer Figure 7.10). During winter the Painted honeyeater is known to migrate further to North Queensland, around Cape York Peninsula, and eastern areas of the Northern Territory. Opportunistic sightings have been recorded in far eastern parts of South Australia (Garnett et al. 2011; Higgins et al. 2001; Pizzey and Knight 2012).

Figure 7.10 **Distribution range of the Painted honeyeater**

Source: ALA (2019)

Biology and reproduction

The Painted honeyeater is typically seen individually or in pairs, less frequently seen in small flocks of up to six birds. This species is known to consume fruit. The species is predominantly observed in areas where mistletoe is abundant. The species is known to have a mixed diet consisting of nectar, berries and insects, defining them an omnivorous and an obligate nectarivore (Oliver et al. 2003).

The species nests in a variety of trees and have been documented to favour mistletoe as a nesting site. The foliage of mistletoe helps with concealment of the nest to protect from predators and subsequent nest failure (Barea 2008; Cooney et al. 2006).

The breeding season generally takes place between October through to March, and can be influenced by environmental conditions and the availability of food resources. Generally, the male Painted honeyeater will arrive at a nesting site several weeks before the female.

Both the male and female Painted honeyeaters maintain the nest, incubate the eggs, brood and feed the young. Nests are generally found approximately 15 m from the ground where the typical clutch consists of 2 eggs, but not uncommonly 1 to 3 eggs can be found. The species are known to raise 1 to 2 broods per season, where eggs are incubated for 13 to 15 days, and young fledge in 14 to 20 days. Box the female and male leave the nest at approximately the same time, generally five months after fledglings leave the nest and food resources decline (DES 2019; Garnett et al. 2011; Whitmore and Eller 1983).

7.10.3 Habitat

The Painted honeyeater is predominantly found in open forest, box-open woodland, eucalypt forest/woodlands, riparian woodlands and acacia woodlands. The Painted honeyeater inhabits environments that have a high prevalence of mistletoe which provides both nesting and food resources. Favourable species including needle-leaved mistletoe *(Amyema cabagei)* and grey mistletoe *(A. quandang)*. An identified key association between the Painted honeyeaters migration south-north is believed to be a result of mistletoe fruit availability and general mistletoe distribution and abundance (DotEE 2015; Keast 1968; Simpson and Day 2004).

7.10.4 Threatening processes

The following have been identified as potentially threatening processes to the Painted honeyeater:

- Habitat loss and fragmentation
- Grazing inhibiting tree recruitment for feed trees (DotEE 2015).

7.10.5 Species resilience

Determination of species resilience is presented in Table 7.10.

7.10.6 References

Atlas of Living Australia (2019), *Grantiella picta*. Viewed 17 September 2019, Available: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:de126daa-e11d-42e0-ace6-7873abe6c96b#.

Barea, L. P. (2008). Nest-site selection by the Painted Honeyeater (Grantiella picta), a mistletoe specialist. Emu, 108, 213-220.

BirdLife International (2019) Species factsheet: Grantiella picta. Downloaded from http://www.birdlife.org on 17/09/2019.

Chapman A (2017), *Grantiella picta*, Available: https://images.ala.org.au/store/2/0/a/1/e183a4e1-b111-444b-b39d-59fd62b01a02/original

Cooney, S. J., Watson, D. M., and Young, J. (2006). Mistletoe nesting in Australian birds: A review. Emu, 106, 1-12.

Department of the Environment and Energy (2015). Conservation Advice Grantiella picta painted honeyeater. Canberra: Department of the Environment. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/470-conservation-advice.pdf. In effect under the EPBC Act from 08 July 2015.

Higgins, P. J., Peter, J. M., and Steele, W. K. (Eds.). (2001). Handbook of Australian, New Zealand and Antarctic birds: Vol. 5. Tyrant-flycatchers to Chats. Oxford University Press: Melbourne. ISBN 0195532589. http://eol.org/pages/919405/details#cite_note-Higgins.2CPeter.2CSteele-2.

Garnett, S., J. Szabo and G. Dutson (2011). *The Action Plan for Australian Birds 2010*. CSIRO Publishing. Available from: http://birdsindanger.net/taxatable.

Keast, A. (1968). Seasonal movements in the Australian honeyeaters (Meliphagidae) and their ecological significance. Emu, 67, 159-209. http://eol.org/pages/919405/details#cite_note-Keast-12.

Knight, R. (2009). Painted honeyeater (Grantiella picta). [image] [online] Available from: **https://www.flickr.com/photos/sussexbirder/8079677675/in/photolist-8Fw6ib-diYsFv-LDPPEM**. [17 September 2019].

Nature Conservation Act 1992 (Queensland): September 2017 list)

Oliver, D. L., Chambers, M. A., Parker, D. G. (2003). Habitat and resource selection of the Painted Honeyeater (Grantiella picta) on the northern floodplains regions of New South Wales. Emu, 103, 171-176. http://eol.org/pages/919405/details#cite_note-OliverChambers-13.

Department of Environment and Science (DES), Painted honeyeater – *Grantiella picta*, Wetland*Info*, Queensland, viewed 17 September 2019, https://wetlandinfo.des.qld.gov.au/wetlands/ecology/components/species/?grantiella-picta.

Table 7.10 **Species resilience questionnaire – Painted honeyeater (*Grantiella picta*)**

Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ■ Increase in intensity as a result of the projected changes **(2)** ■ Unlikely to change as a result of the projected changes **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Key threats to this species include: ■ Habitat loss and fragmentation ■ Grazing inhibiting tree recruitment for feed trees The project will result in loss and fragmentation of existing habitat and will contribute to threatening processes.	2
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ■ Decline or shift from current location (3) ■ Stay the same and in approximately the same location **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Specific breeding habitat is not anticipated to be cleared as part of the project activities.	0
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ■ Decline or shift from current location **(2)** ■ Stay the same and in approximately the same location **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Areas of foraging habitat will be removed as part of the project activities	2
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ■ Expected to decrease or habitat components required for breeding unknown (3) ■ Expected to decrease or habitat components required for breeding unknown (3) ■ Unlikely to change **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Breeding components of this species are not expected to change in response to project	0

Item	Question	Criteria	Species response	Score
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ▪ Expected to decrease or habitat components required for non-breeding unknown **(2)** ▪ Unlikely to change **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Non-breeding components of this species are not expected to change in response to project	0
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	Low ability to disperse **(2)** ▪ Mobile, but dispersal is sex-biased (only one sex disperses) **(1)** ▪ Very mobile, both sexes disperse **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This is a highly vagile species and has a high potential to colonize new areas of habitat.	0
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	▪ Species migratory habitats will be adversely affected **(2)** ▪ Species migratory habitats will not be adversely affected **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Species migratory patterns are not likely to be altered in response to the project activities	0
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(2)** ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species has limited flexible strategies to cope with resource fluctuations	2
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ▪ Once per year or less **(2)** ▪ More than once per year **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The species is known to raise multiple broods per year	0

Item	Question	Criteria	Species response	Score
Q10.	Food resources: Are important food resources for this species expected to change?	▪ Primary food source(s) are expected to be negatively impacted by projected changes **(2)** ▪ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species has specific feeding habitats that may be impacted by project related activities	2
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: ▪ Is expected to increase as a result of the projected changes **(2)** ▪ Is not expected to be impacted by the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Increased levels of predation and the species vulnerability is not expected to be impacted by the project activities	0
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	▪ Disease prevalence is expected increase with projected changes **(2)** ▪ No known effects of expected changes on disease prevalence (0) ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The nature of works is unlikely to introduce disease that may cause species decline	0
Q13.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes **(2)** ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	There are no major competitors recognised as a key threating process to this species. No change is expected.	0
Total score				8
Species resilience				**Moderate**

Pizzey, G., and Knight, G. (2012). The field guide to the birds of Australia (9th ed.). HarperCollins: Sydney. ISBN 978-0-7322-9193-8. http://eol.org/pages/919405/details#cite_note-Higgins.2CPeter.2CSteele-2.

Simpson, K., and Day, N. (2004), *Field Guide to the Birds of Australia*, 7th ed. Australia: Penguin, 210.

Whitmore, M. J., and Eller, C. M. (1983). Observations at a nest of Painted Honeyeaters. Emu, 83(3) 199-202.

7.11 White-throated needletail (*Hirundapus caudacutus*)

7.11.1 Status

EPBC Act – Marine and Migratory (Bonn/CAMBA/JAMBA/ROKAMBA)

NC Act – Special least concern

BC Act – Not listed

7.11.2 Biology and ecology

Characteristics

The White-throated needletail (*Hirundapus caudacutus*) is a large swift with a thickset, cigar-shaped body, a stubby tail and pointed wings (refer Photograph 7.9). This species typically measures 20 cm in length and approximately 115 to 120 g in weight. Adults exhibit a dark-olive head and neck, with an iridescent gloss on the crown, whilst the mantle and the back are paler and greyish. The upperwings are blackish (often with a greenish gloss), with a contrasting white patch at the base of the trailing edge. The face is dark-olive with a narrow, white band across the forehead, and lores and a white patch on the chin and throat. The underparts are generally dark-olive except for a U-shaped band across the rear flanks, the vent and the undertail coverts, and the undertail is black with a greenish gloss (DotEE 2019).

Photograph 7.9 White-throated needletail (*Hirundapus caudacutus*)

Source: Knight (2007)

Known distribution

White-throated needletails breed in Asia, from central and south-eastern Siberia and Mongolia, east to the Maritime Territories of Russia, Sakhalin and the Kuril Islands and south to northern Japan and north eastern China. Most White-throated needletails spend the non-breeding season in Australia, and occasionally in New Guinea and New Zealand (DotEE 2019).

The White-throated needletail is considered widespread in eastern and southeastern Australia. In eastern Australia, it is recorded in all coastal regions of Queensland and NSW, extending inland to the western slopes of the Great Divide and occasionally onto the adjacent inland plains (Barrett et al. 2003; DotEE 2019) (refer Figure 7.11).

Figure 7.11 Distribution range of the White-throated needletail

Source: ALA (2019)

Biology and reproduction

In Australia the White-throated needletail has been recorded eating a wide variety of insects, including beetles, cicadas, flying ants, bees, etc. (DotEE 2019).

White-throated needletails are non-breeding migrants in Australia. Breeding takes place in northern Asia from April to October (DotEE 2019; Higgins 1999).

7.11.3 Habitat

In Australia, the White-throated needletail is almost exclusively aerial, flying at heights of less than 1 m up to more than 1,000 m above the ground. White-throated needletails often forage along the edges of low pressure systems, which both lift their food sources, and assist with their flight. The species has been recorded roosting in trees in forests and woodlands, both among dense foliage in the canopy or in hollows (DotEE 2019).

This species is known to occur over most types of habitat, however, they are most often recorded above wooded areas, including open forest and rainforest, and may also fly between trees or in clearings, below the canopy. In coastal areas, they are soften seen flying over sandy beaches or mudflats, and often around coastal cliffs and areas with prominent updraughts, such as ridges and sand-dunes (Cooper 1971; DotEE 2019; Higgins 1999).

7.11.4 Threatening processes

There appear to be few threats to the populations of White-throated Needletails in Australia, but there is always the potential threat of habitat destruction and predation by feral animals (DotEE 2019).

7.11.5 Species resilience

Determination of species resilience is presented in Table 7.11.

7.11.6 References

Atlas of Living Australia (2019). *Hirundapus caudacutus*. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:21205690-54fd-452a-9772-d3e1f8780dff# [Accessed 13 September 2019].

Barrett, G., Silcocks A., Barry S., Cunningham R. and Poulter R. (2003). *The New Atlas of Australian Birds*. Melbourne, Victoria: Birds Australia.

Cooper, R.P. (1971). High flying swifts. *Australian Bird Watcher*. 4:79-80.

Department of the Environment and Energy (2019). *Hirundapus caudacutus* in Species Profile and Threats Database, Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=682 [Accessed 13 September 2019].

Higgins, P.J. (ed.) (1999). Handbook of Australian, New Zealand and Antarctic Birds. Volume Four - Parrots to Dollarbird. Melbourne: Oxford University Press.

Knight, R. (2007). White-throated needletail (*Hirundapus caudacutus*). [image] [online] Available from: **https://www.flickr.com/photos/sussexbirder/8077024804/in/photolist-dCzG2D-diJS5m-diJRGS-s1aH3F**. [17 September 2019].

Table 7.11 **Species resilience questionnaire – White-throated needletail (*Hirundapus caudacutus*)**

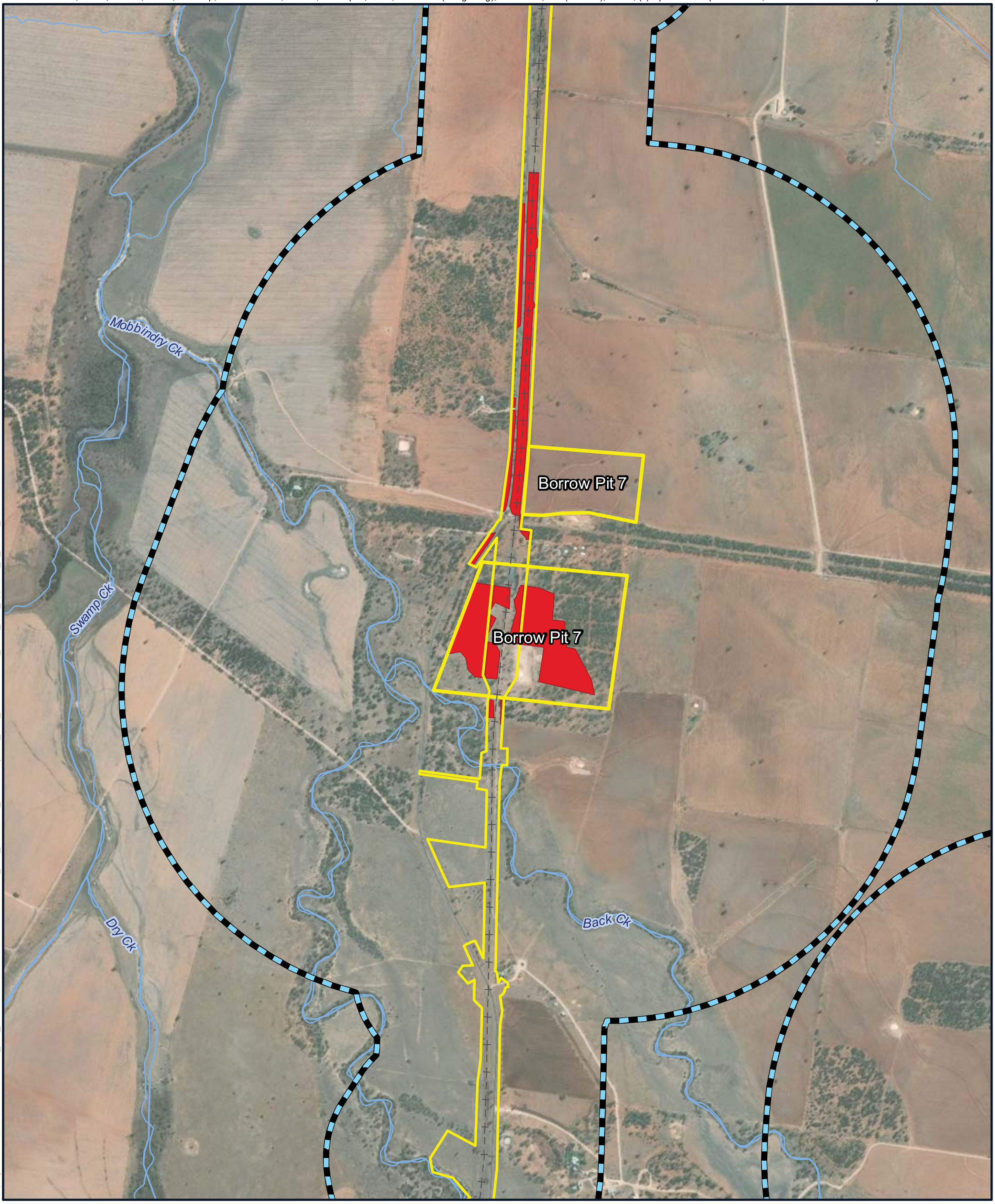
Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes **(2)** ▪ Unlikely to change as a result of the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	There are no identified threatening processes for this species	0
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ▪ Decline or shift from current location (3) ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species does not breed within Australia. The species does not appear to be restricted to highly specialised environments to facilitate breeding activities. As such Project works are not considered likely to reduce the area of breeding habitat available for the species.	0
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ▪ Decline or shift from current location **(2)** ▪ Stay the same and in approximately the same location **(0)** ▪ *Due to species sensitivities', any impact on this value is expected to have an adverse impact on the species **(120)***	The species is an aerial forager and thus the species does not appear to be restricted to highly specialised environments to facilitate non-breeding activities. Project works are not considered likely to reduce the area of non-breeding habitat available for the species.	0
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Expected to decrease or habitat components required for breeding unknown (3) ▪ Unlikely to change **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species does not breed in Australia. This species is not considered reliant on specialised habitat components to facilitate breeding and as such Project works are not expected to significantly impact any breeding habitat resources for the species.	0

Item	Question	Criteria	Species response	Score
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ▪ Expected to decrease or habitat components required for non-breeding unknown **(2)** ▪ Unlikely to change **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The species does not appear to require any specific, specialised habitat components to facilitate non-breeding activities. Subsequently, Project works are not expected to significantly impact reduce the quantity of non-breeding habitat resources for the species.	0
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	▪ Low ability to disperse **(2)** ▪ Mobile, but dispersal is sex-biased (only one sex disperses) **(1)** ▪ Very mobile, both sexes disperse **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The species is very mobile with a high ability to disperse as evident by its migratory nature	0
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	▪ Species migratory habitats will be adversely affected **(2)** ▪ Species migratory habitats will not be adversely affected **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The Project works will not create a barrier to species movement or separate vital habitats	0
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(2)** ▪ Flexible strategies to cope with variable resources across multiple years (e.g. alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The species is arterial and well suited to cope with resource fluctuations	0
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ▪ Once per year or less **(2)** ▪ More than once per year **(0)** ▪ *Due to species sensitivities', any impact on this value is expected to have an adverse impact on the species **(120)***	This species does not breed within Australia	0

Item	Question	Criteria	Species response	Score
Q10.	Food resources: Are important food resources for this species expected to change?	■ Primary food source(s) are expected to be negatively impacted by projected changes **(2)** ■ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species is insectivores consuming insects whilst in flight. Food availability for this species is not expected to change as part of the project impacts.	0
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: ■ Is expected to increase as a result of the projected changes **(2)** ■ Is not expected to be impacted by the projected changes **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The project is not expected to result in increased predation upon this species	0
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	■ Disease prevalence is expected increase with projected changes **(2)** ■ No known effects of expected changes on disease prevalence (0) ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The nature of works is unlikely to introduce disease that may cause species decline	0
Q13.	Competitors: Are populations of important competing species expected to change?	■ Major competitor species are expected to be positively impacted by projected changes **(2)** ■ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	There are no major competitors recognised as a key threating process to the migratory marine species subject to this assessment	0
Total score				0
Species resilience				**High**

Appendix C
AIAM outputs

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Existing rail (non-operational)
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

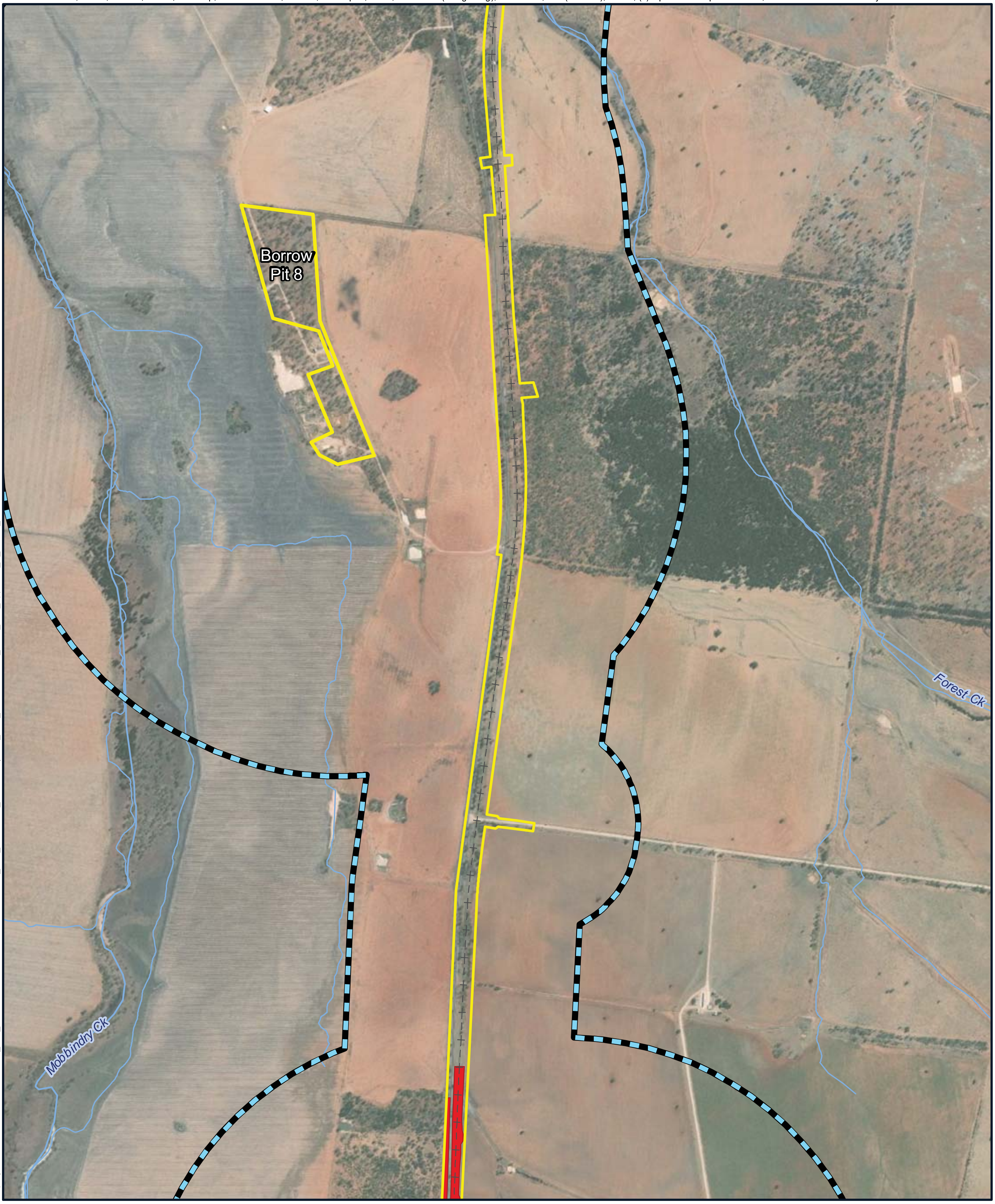
0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border
Appendix C AIAMs output: Brigalow TEC

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3
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North Star to NSW/QLD border

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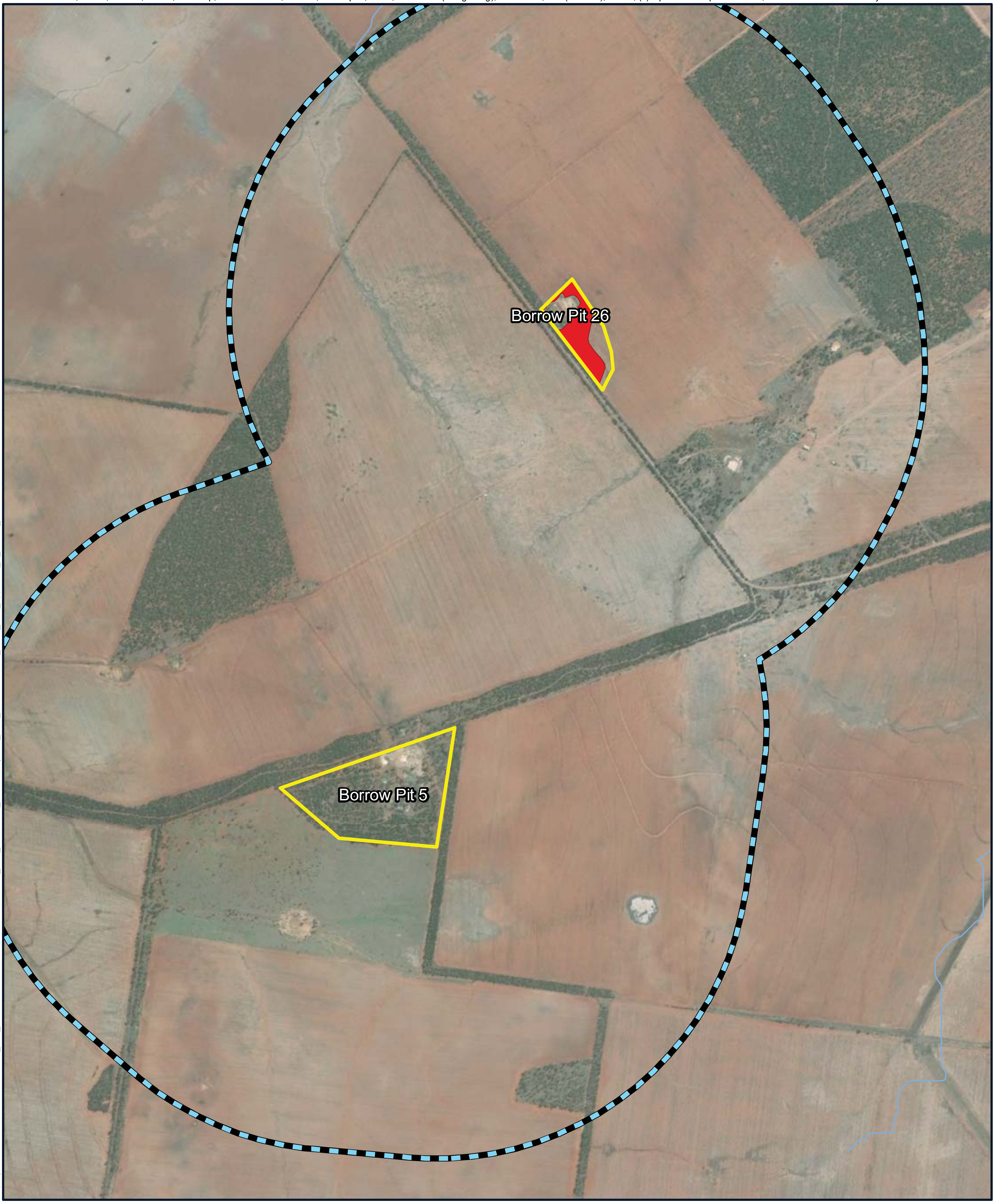

Legend

- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Date: 09/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

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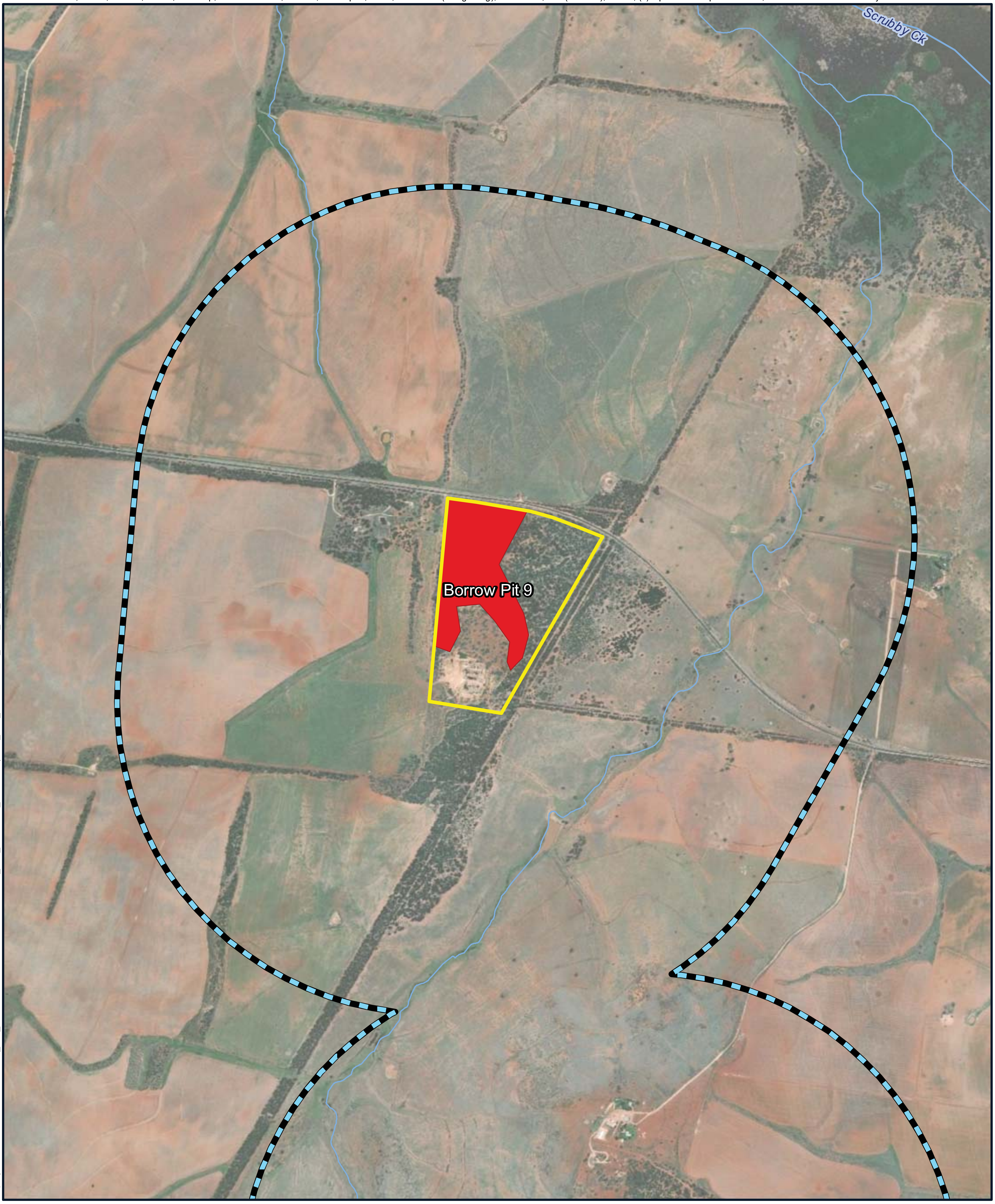

Legend

Watercourses
Study area
Subject land
Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Brigalow TEC

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Legend

- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

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North Star to NSW/QLD border

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Legend

- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3

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North Star to NSW/QLD border

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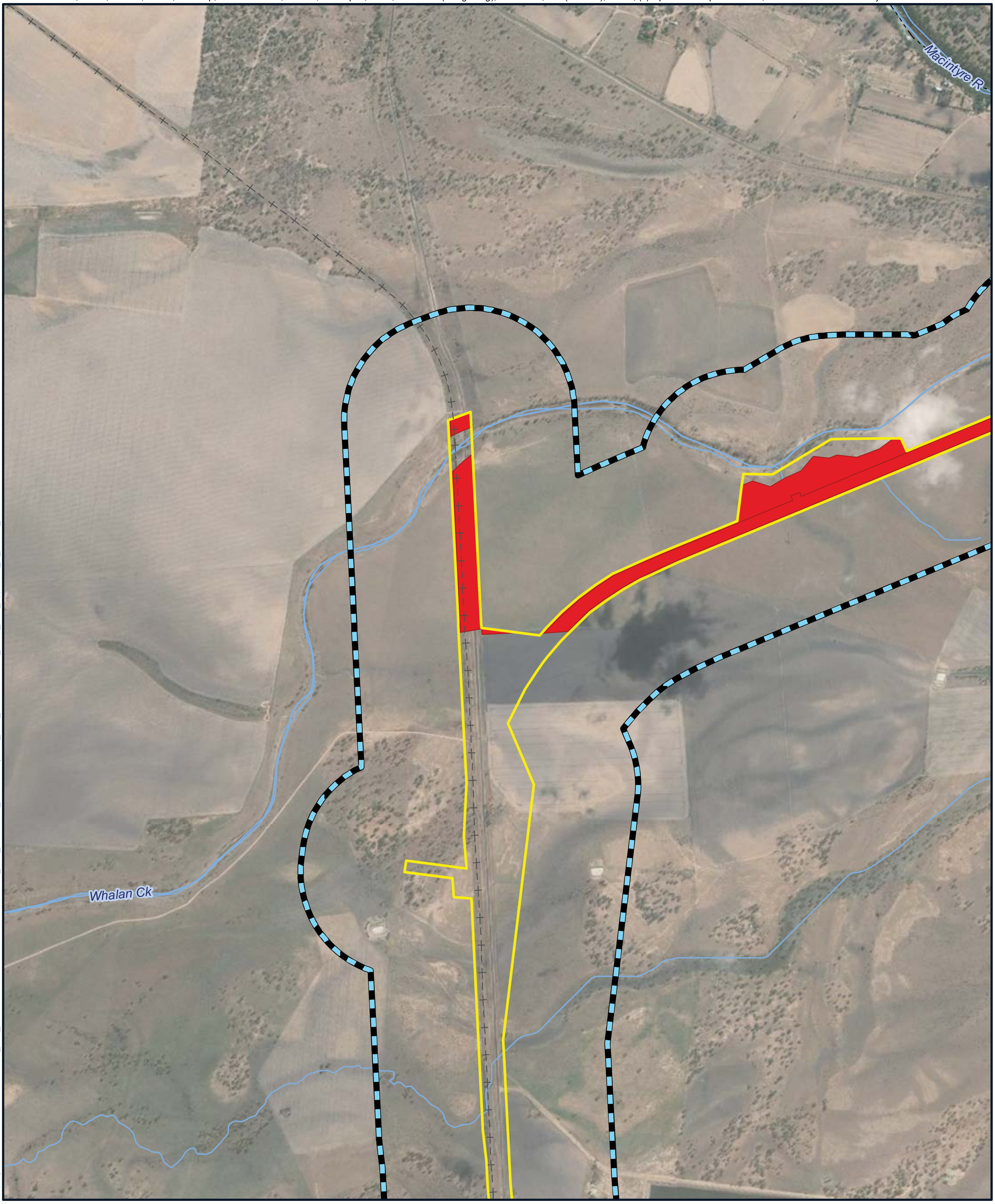

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Legend

- Existing rail (non-operational)
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Date: 09/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Natural grasslands TEC

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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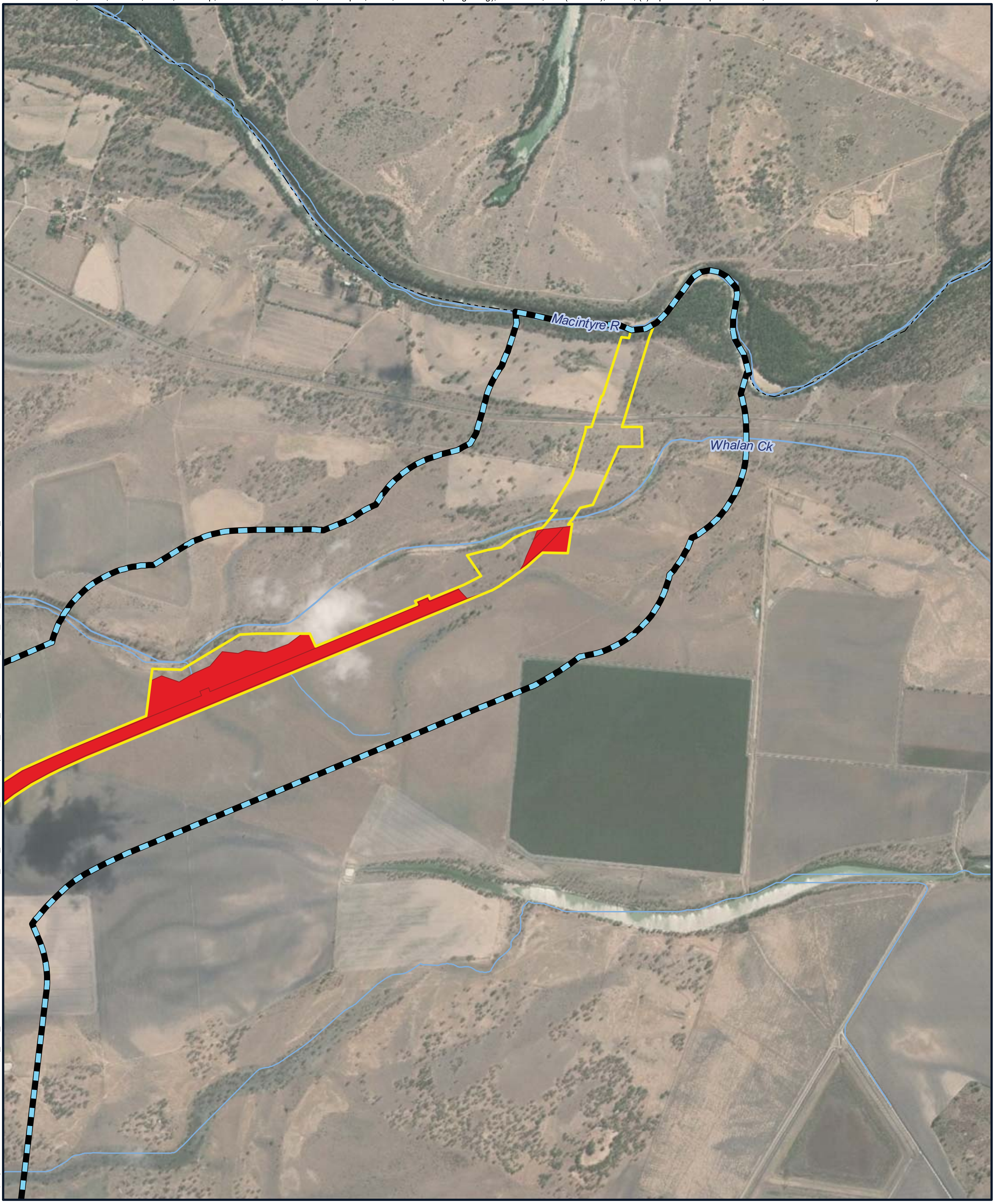

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Legend

- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Natural grasslands TEC

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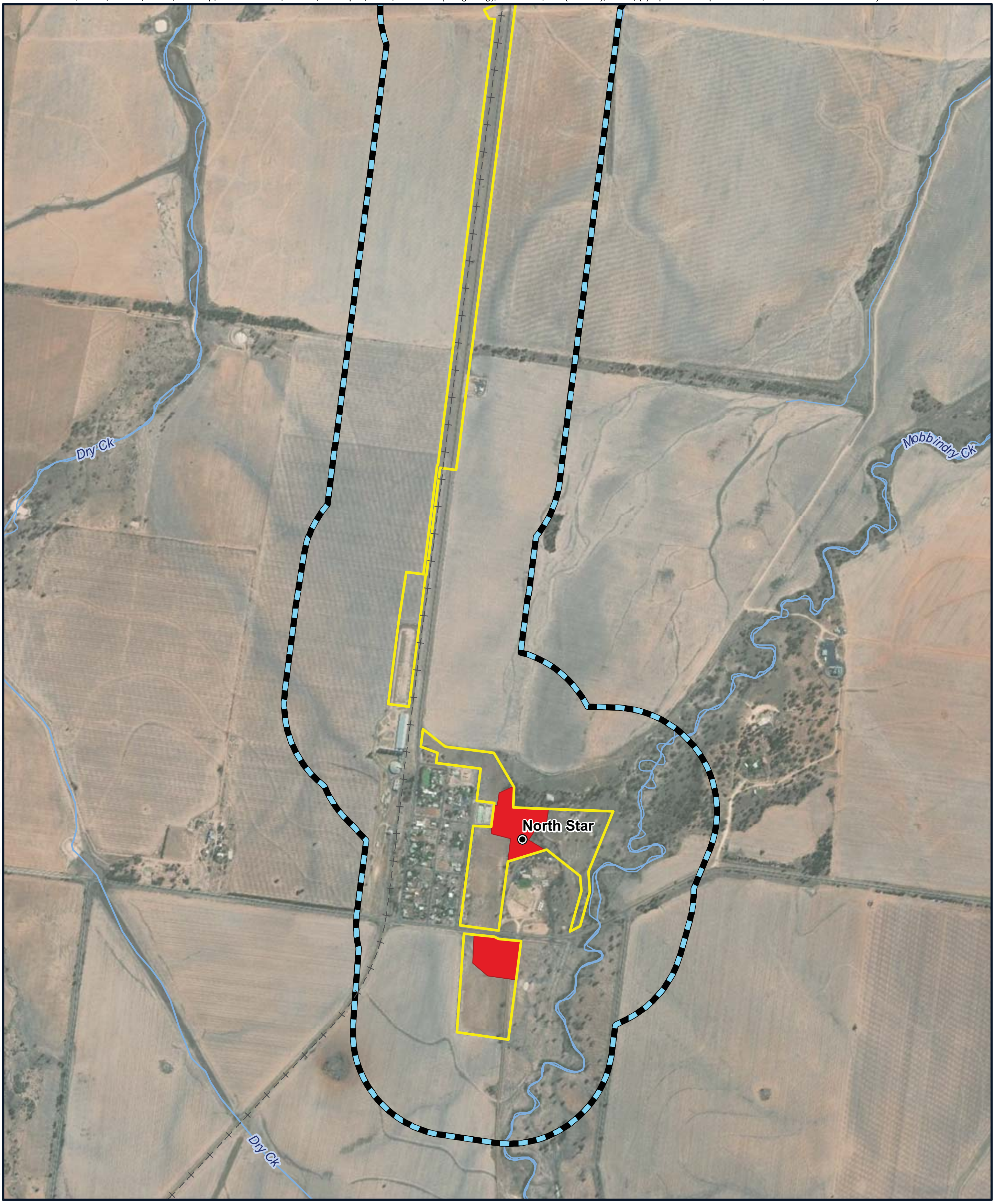

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Legend

- Localities
- Existing rail (non-operational)
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Date: 09/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Poplar box TEC

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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Legend

- Existing rail (operational)
- Existing rail (non-operational)
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3

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North Star to NSW/QLD border

Appendix C AIAMs output: Poplar box TEC

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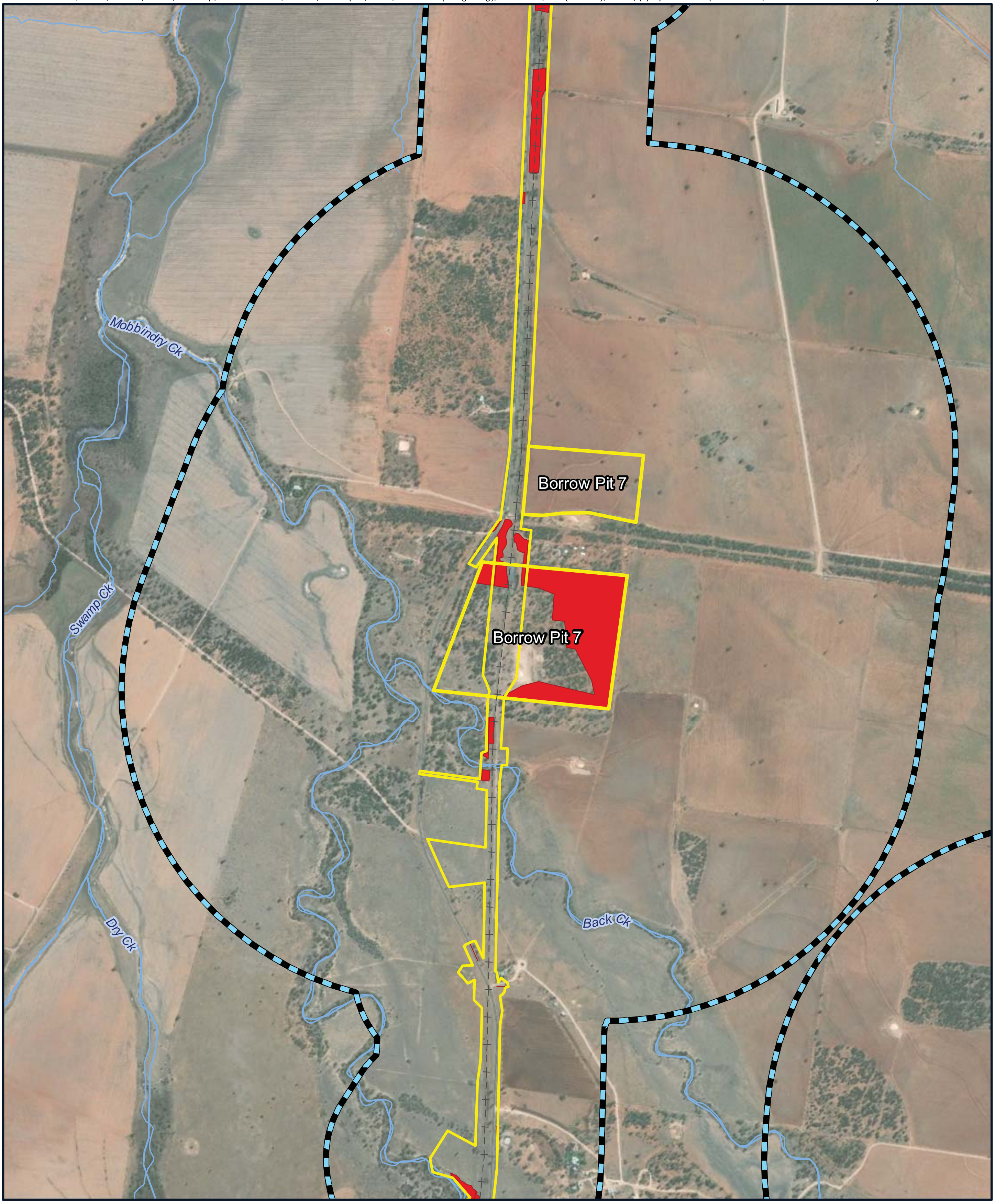

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Legend

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- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
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North Star to NSW/QLD border

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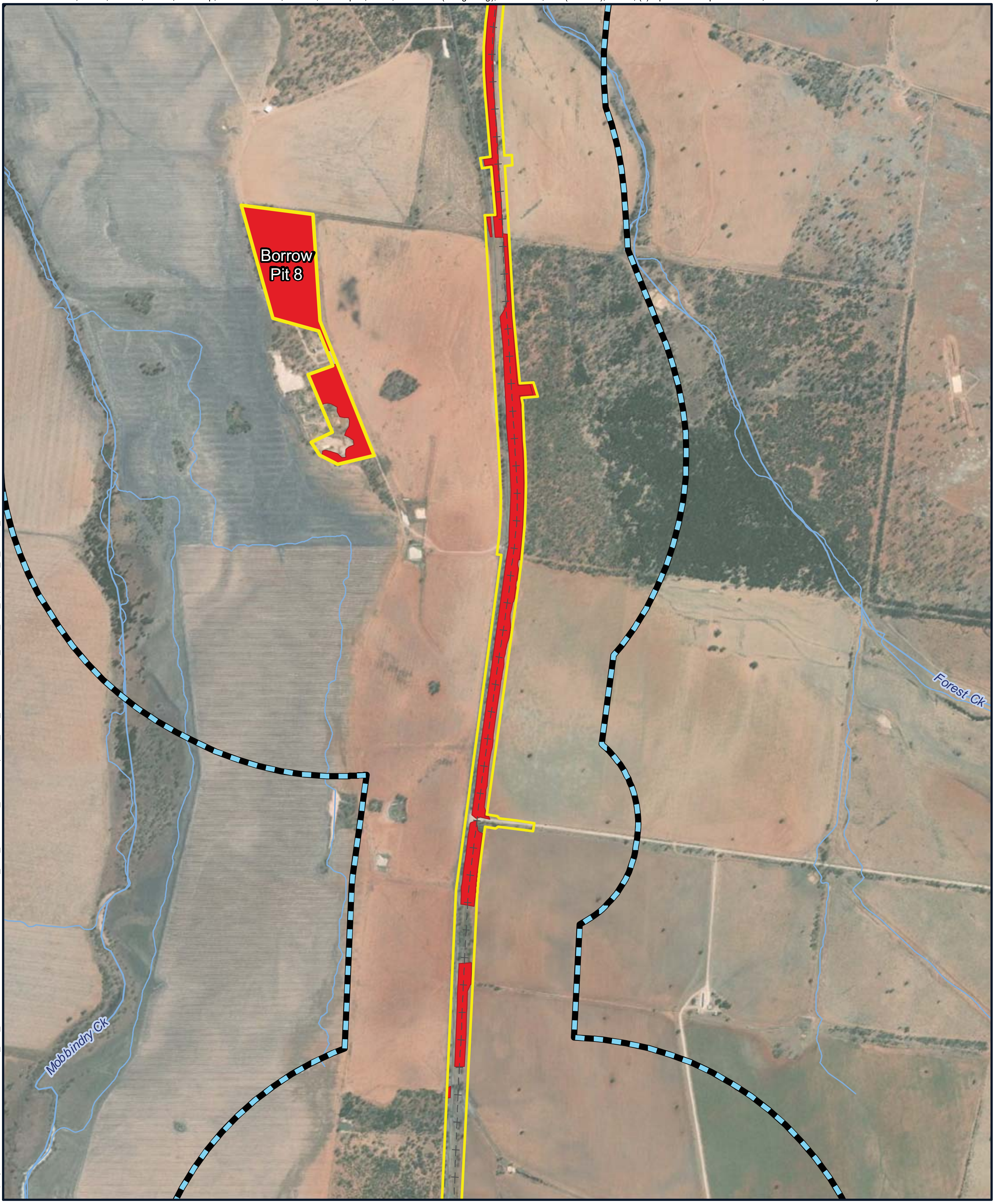

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Legend

- Existing rail (non-operational)
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

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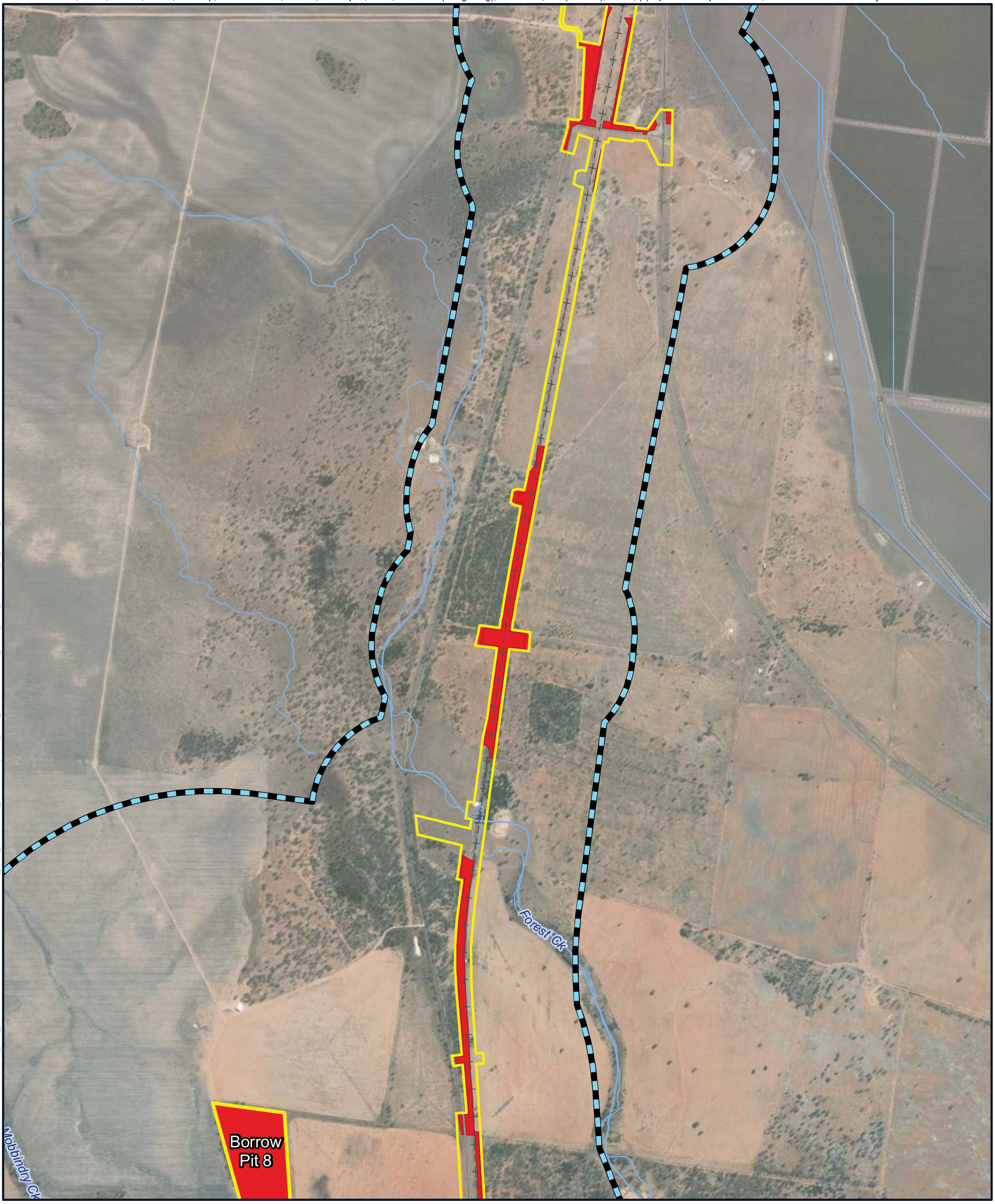

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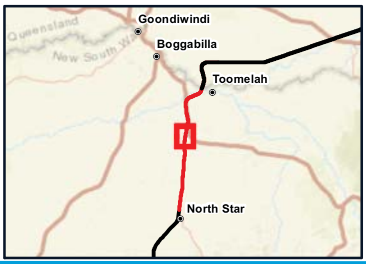

A4 scale: 1:25,000

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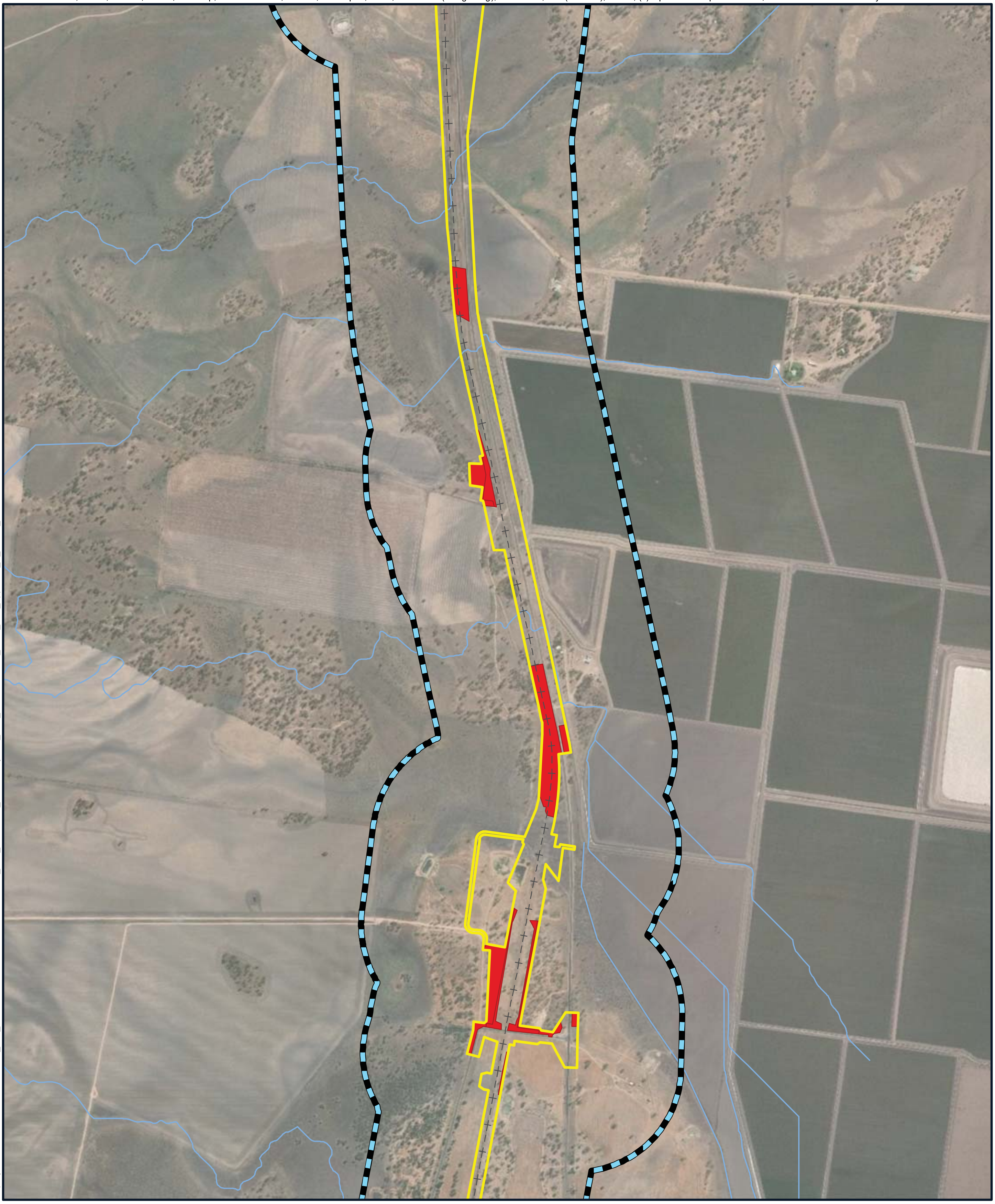

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Legend

- -+- Existing rail (non-operational)
- Study area
- Subject land
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A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Poplar box TEC

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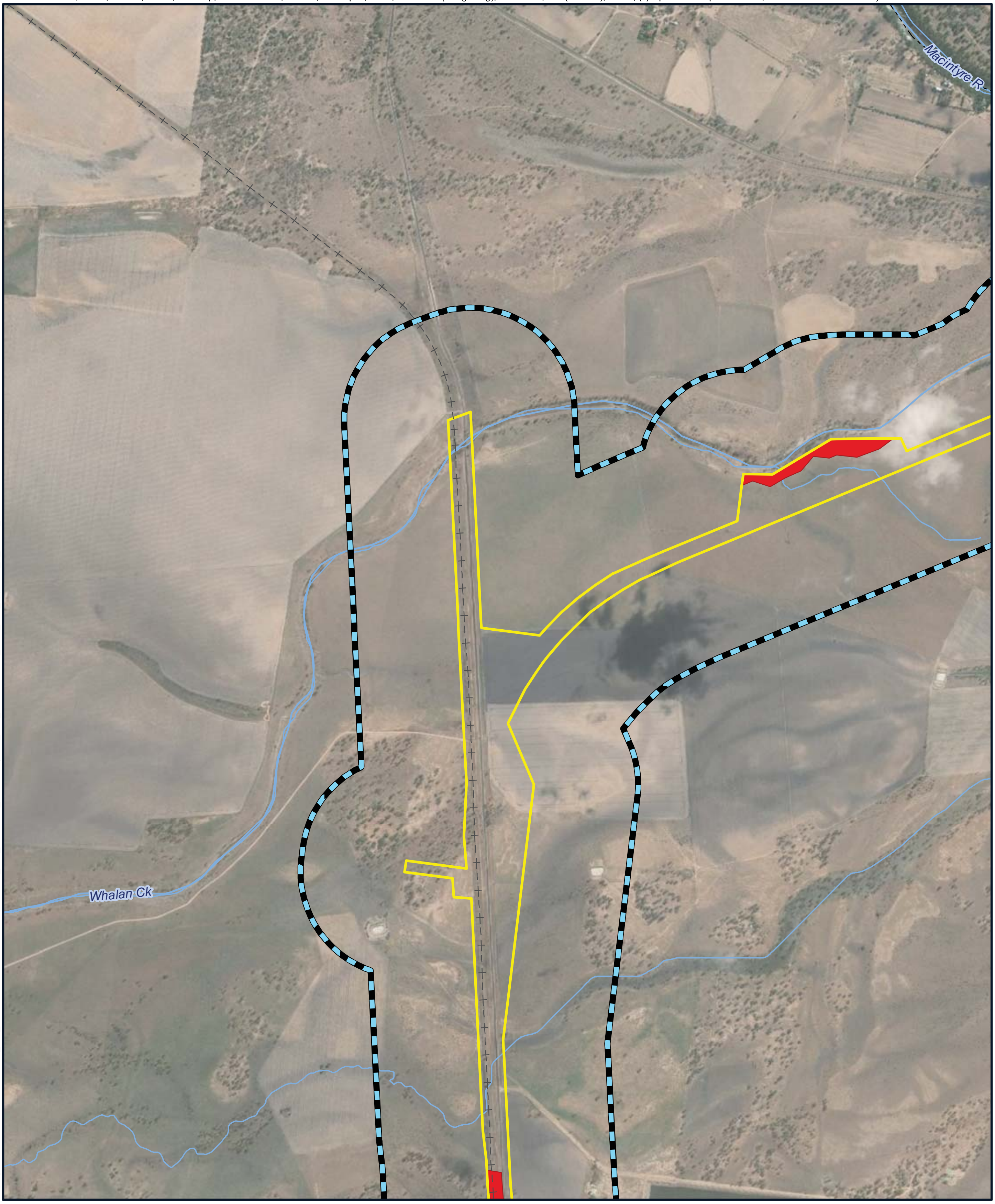

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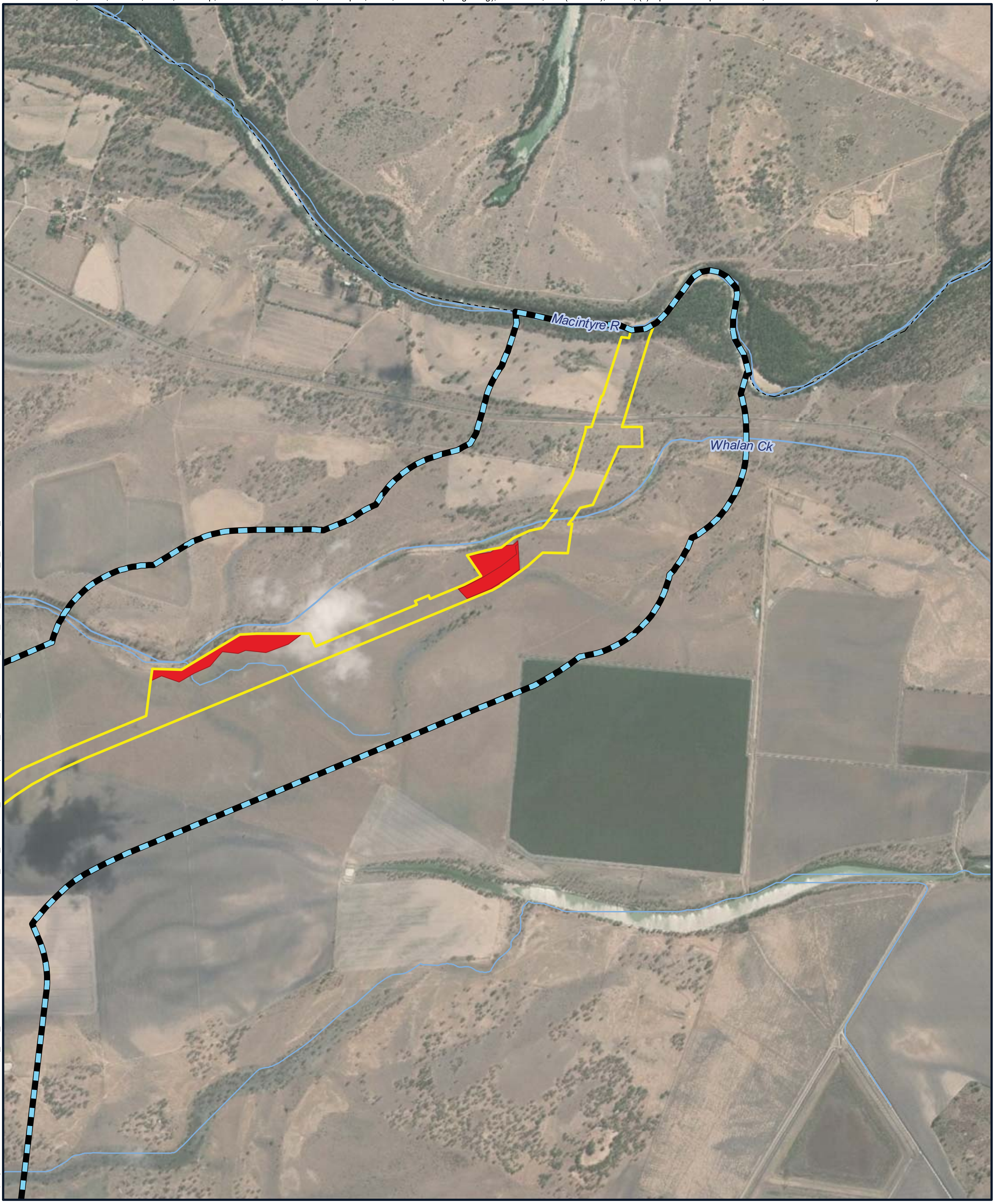
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

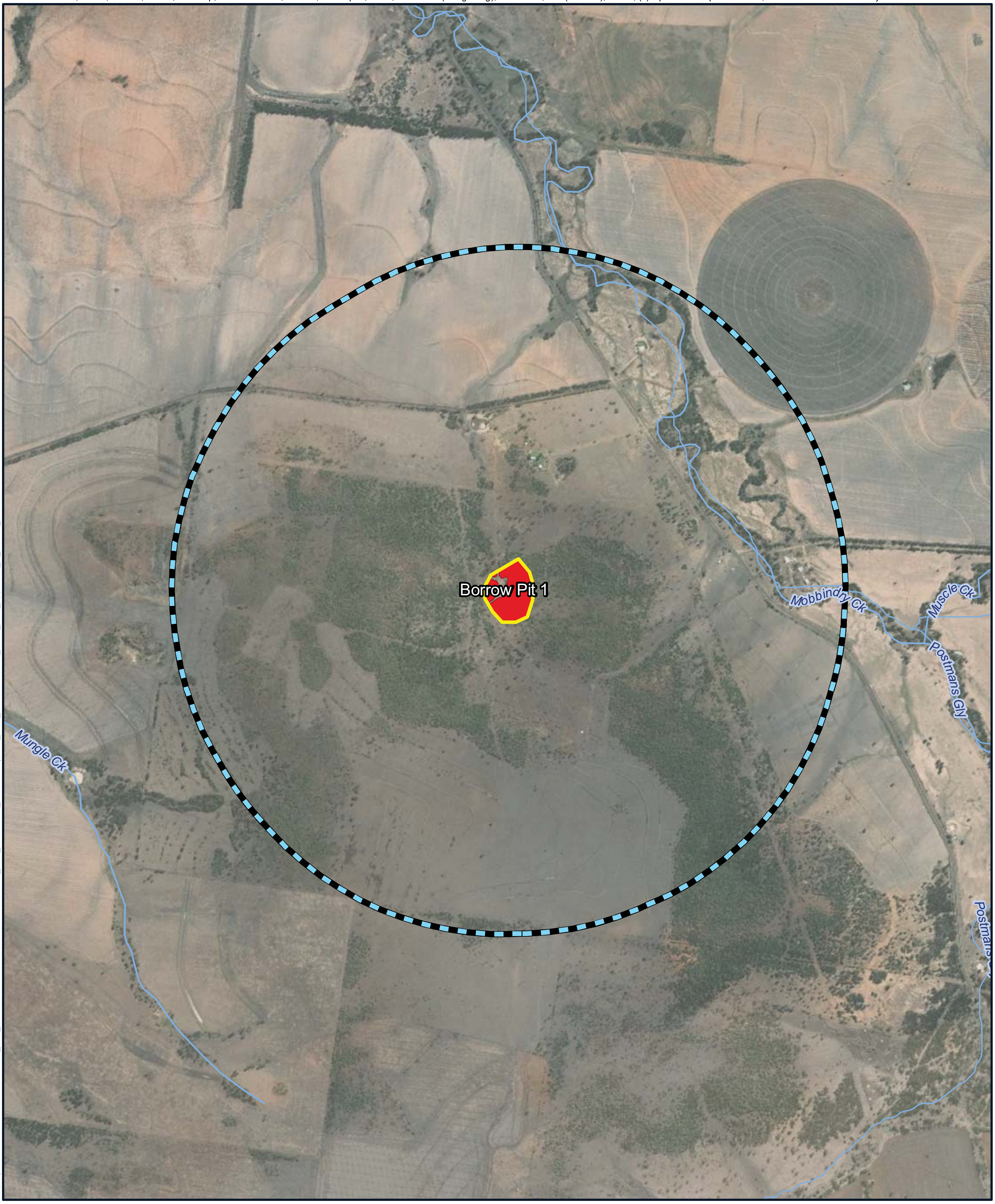
Date: 09/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Poplar box TEC

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

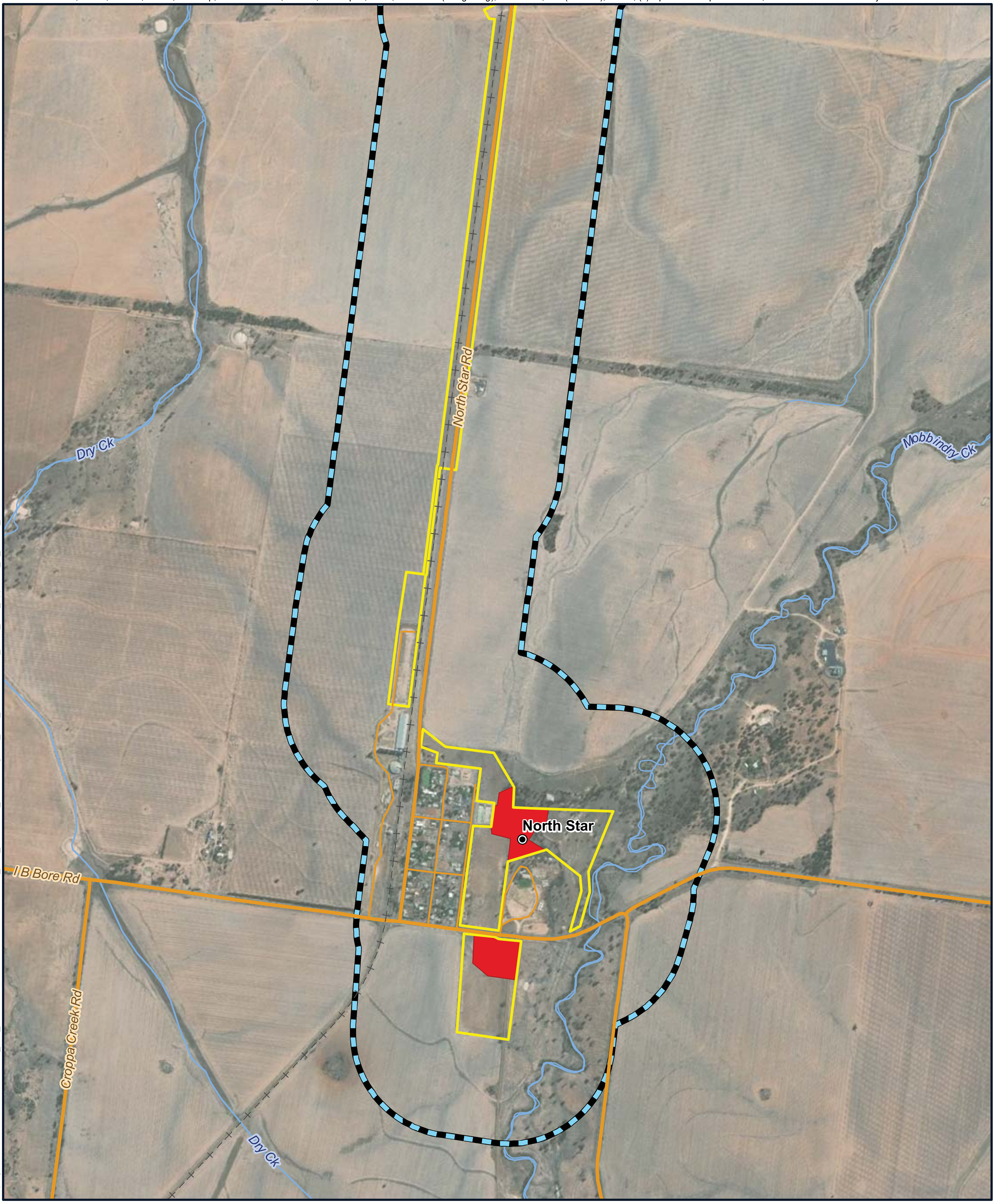
Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: SEVT TEC

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Localities
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
***Dichanthium setosum* (Bluegrass)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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Legend

- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

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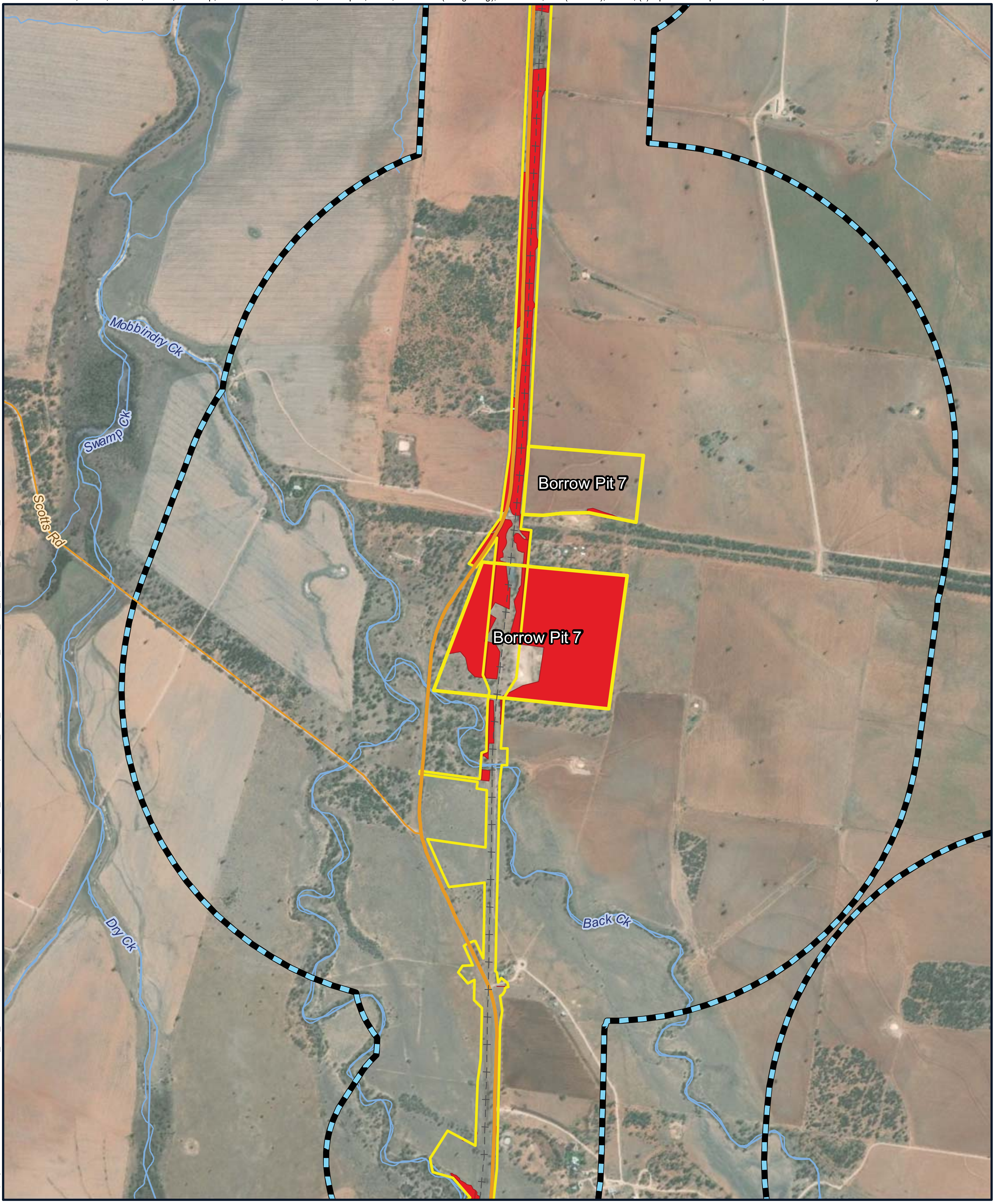
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
***Dichanthium setosum* (Bluegrass)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5km

Future Freight
Integrating Community, Environment and Engineering

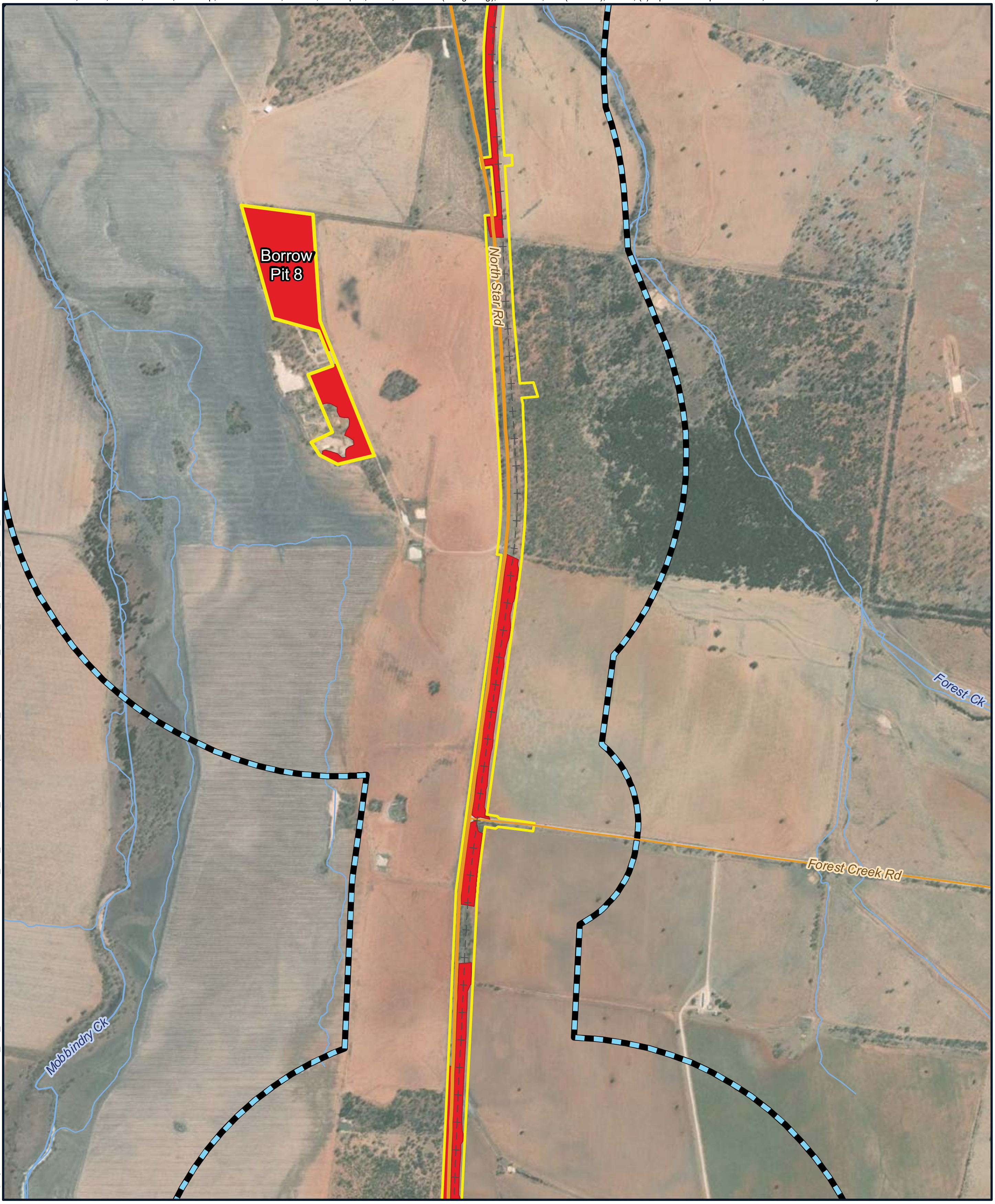
Date: 09/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
***Dichanthium setosum* (Bluegrass)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5km

Future Freight
Integrating Community, Environment and Engineering

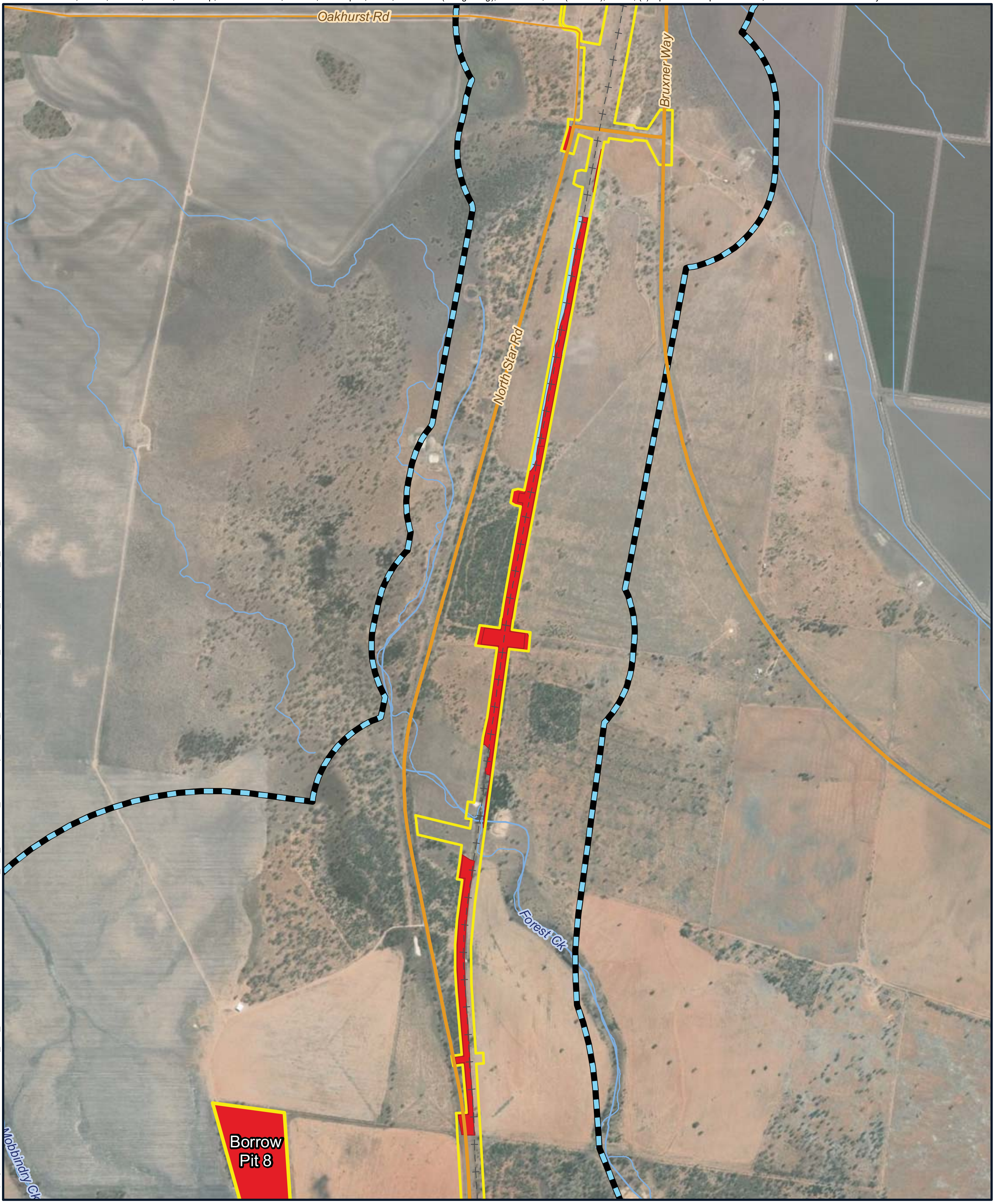
Date: 09/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
***Dichanthium setosum* (Bluegrass)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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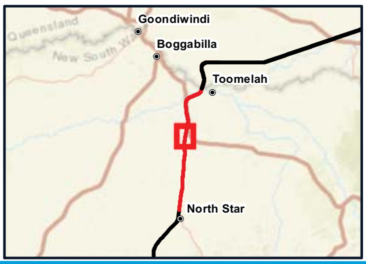
Legend

- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
***Dichanthium setosum* (Bluegrass)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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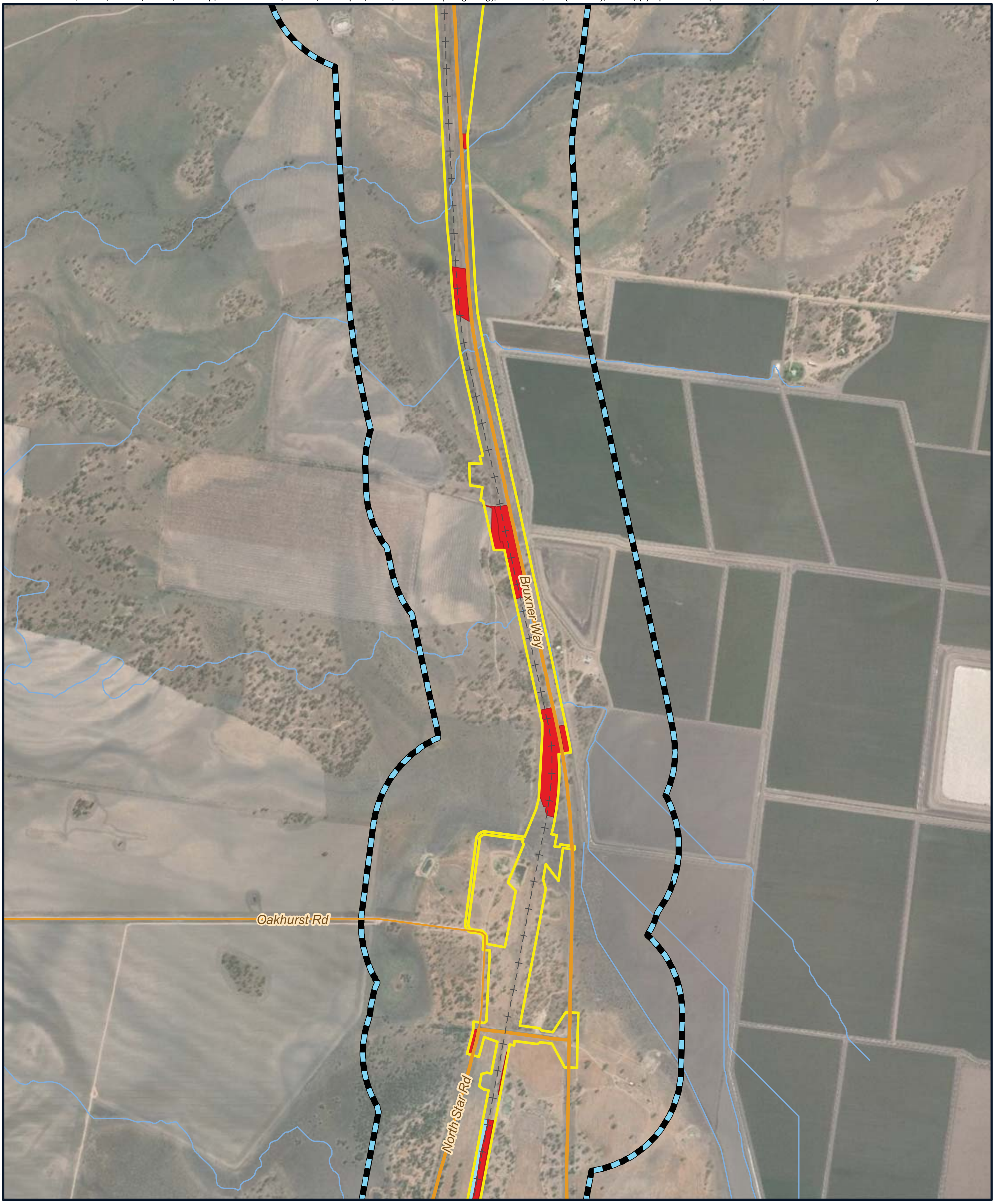


Legend

- Existing rail (non-operational)
- Major roads
- Minor roads
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

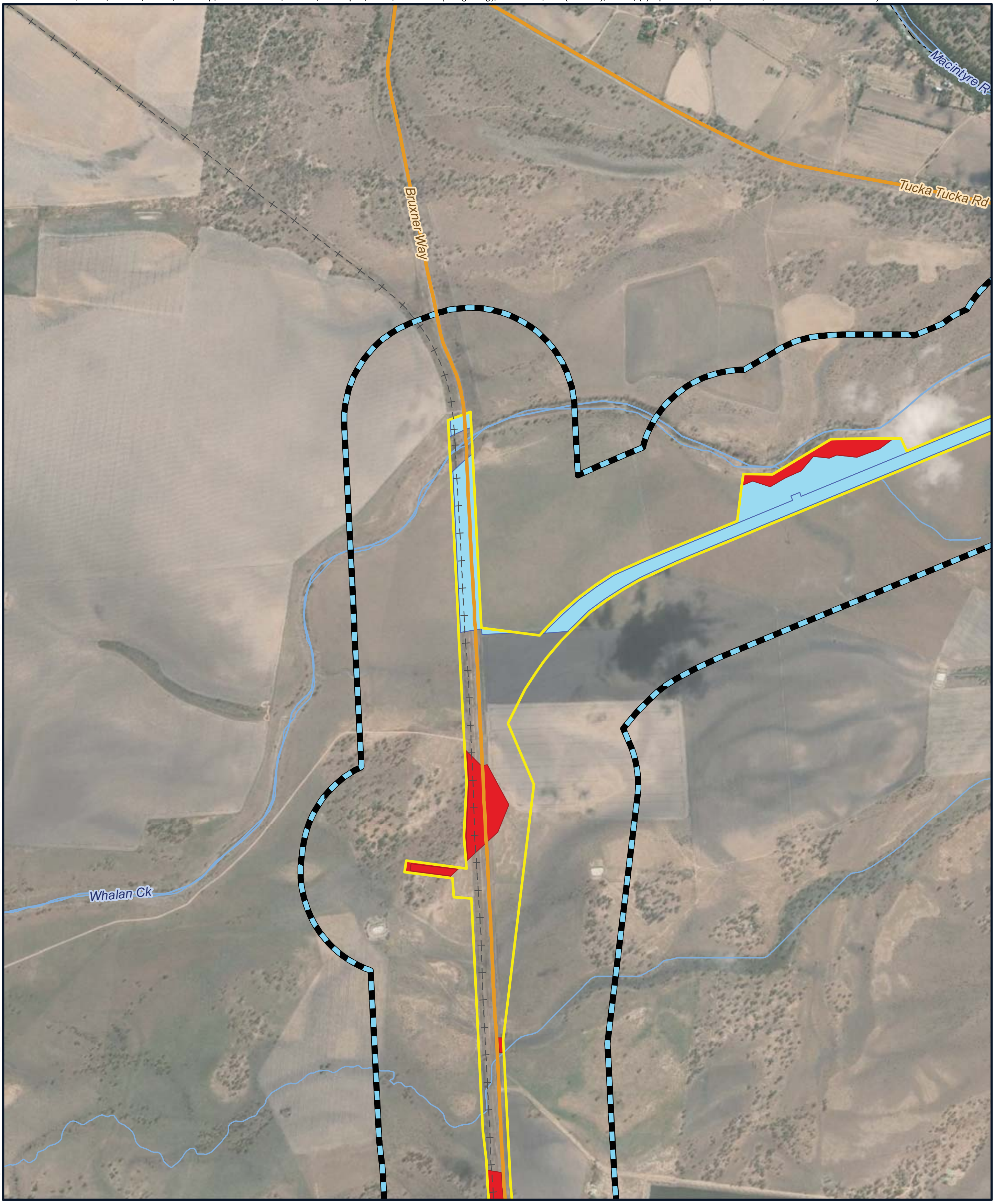
Date: 09/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
***Dichanthium setosum* (Bluegrass)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Existing rail (non-operational)
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5km

Future Freight
Integrating Community, Environment and Engineering

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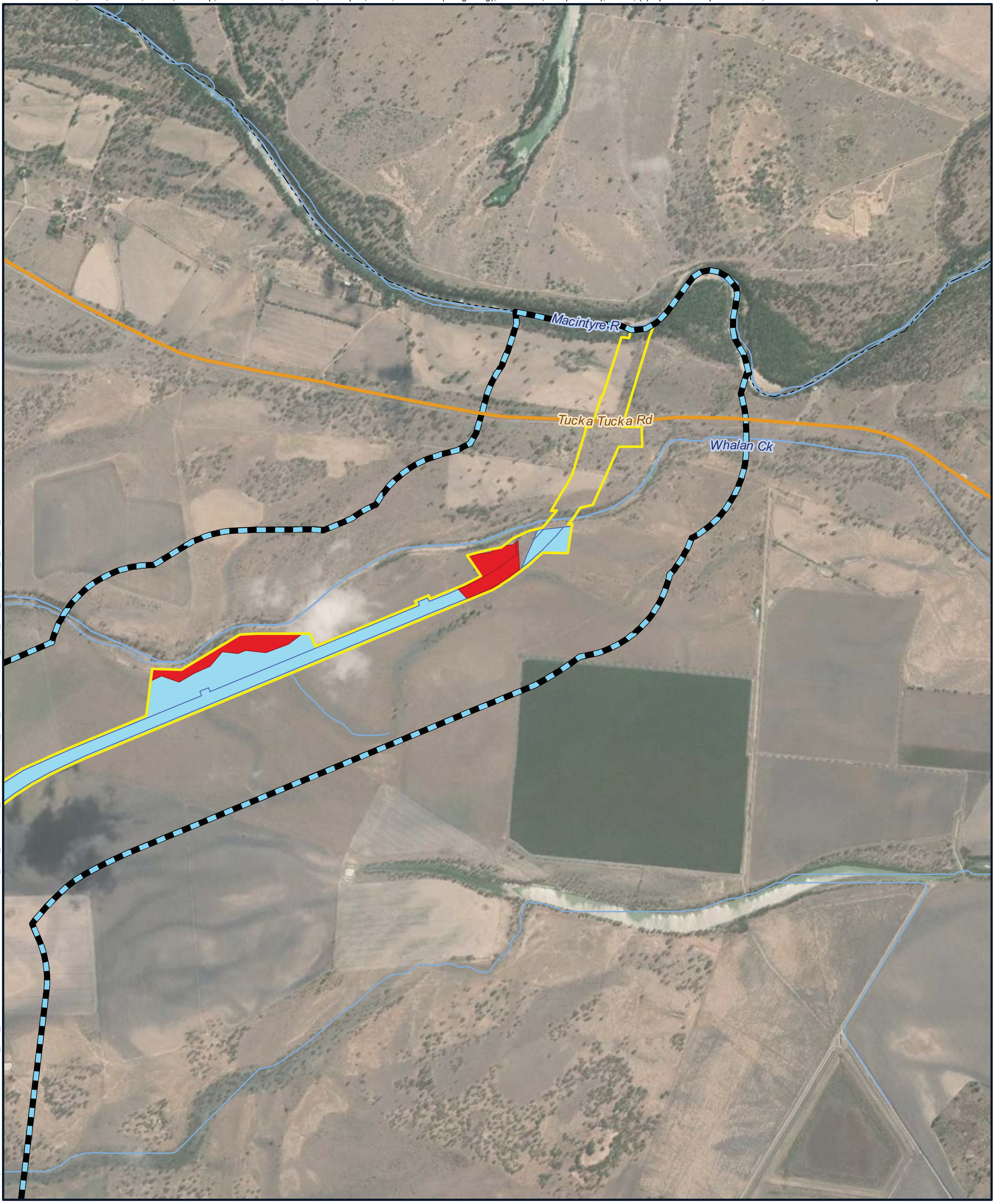
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
***Dichanthium setosum* (Bluegrass)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
***Dichanthium setosum* (Bluegrass)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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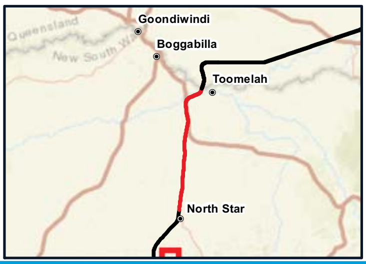
Legend

Major roads
Watercourses
Study area
Subject land
Adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
***Dichanthium setosum* (Bluegrass)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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Legend

Minor roads
Study area
Subject land
Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

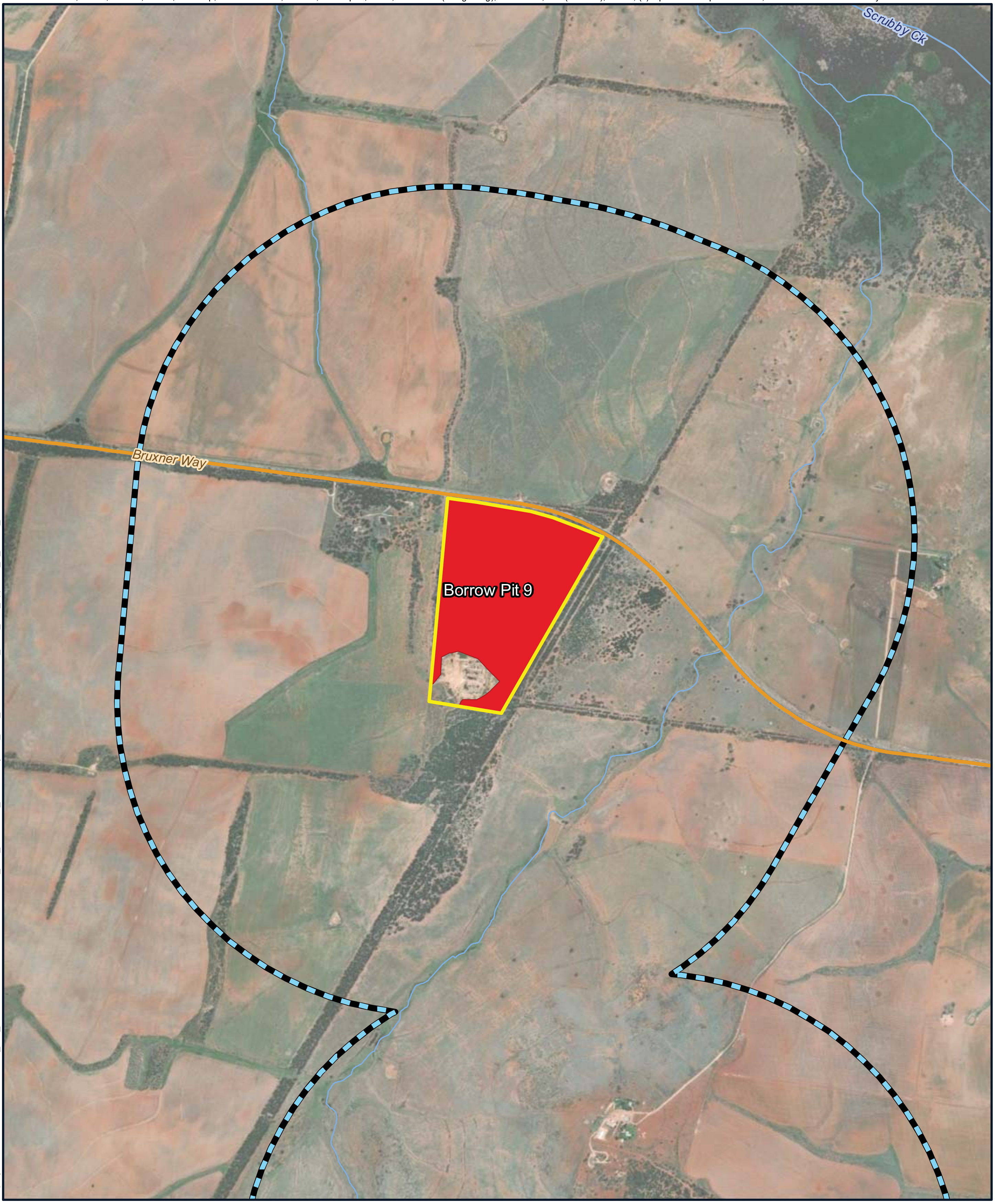
Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
***Dichanthium setosum* (Bluegrass)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

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Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
***Dichanthium setosum* (Bluegrass)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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Legend

Major roads
Minor roads
Watercourses
Study area
Subject land
Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5km

Future Freight
Integrating Community, Environment and Engineering

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Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
***Dichanthium setosum* (Bluegrass)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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Legend

- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

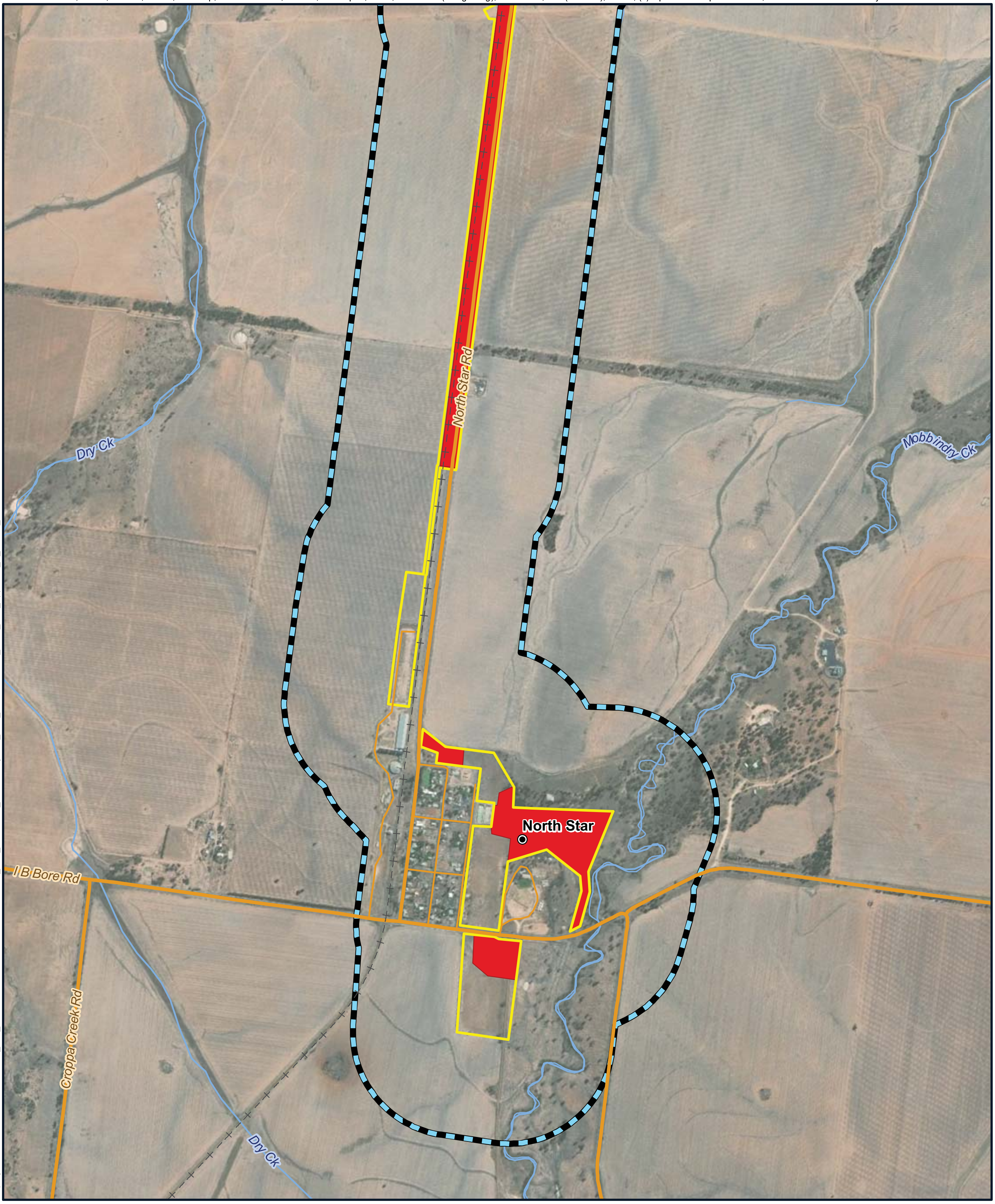
Date: 09/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
***Dichanthium setosum* (Bluegrass)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Localities
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

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North Star to NSW/QLD border

Appendix C AIAMs output:
Homopholis belsonii **(Belsons panic)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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Legend

- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5km

Future Freight
Integrating Community, Environment and Engineering

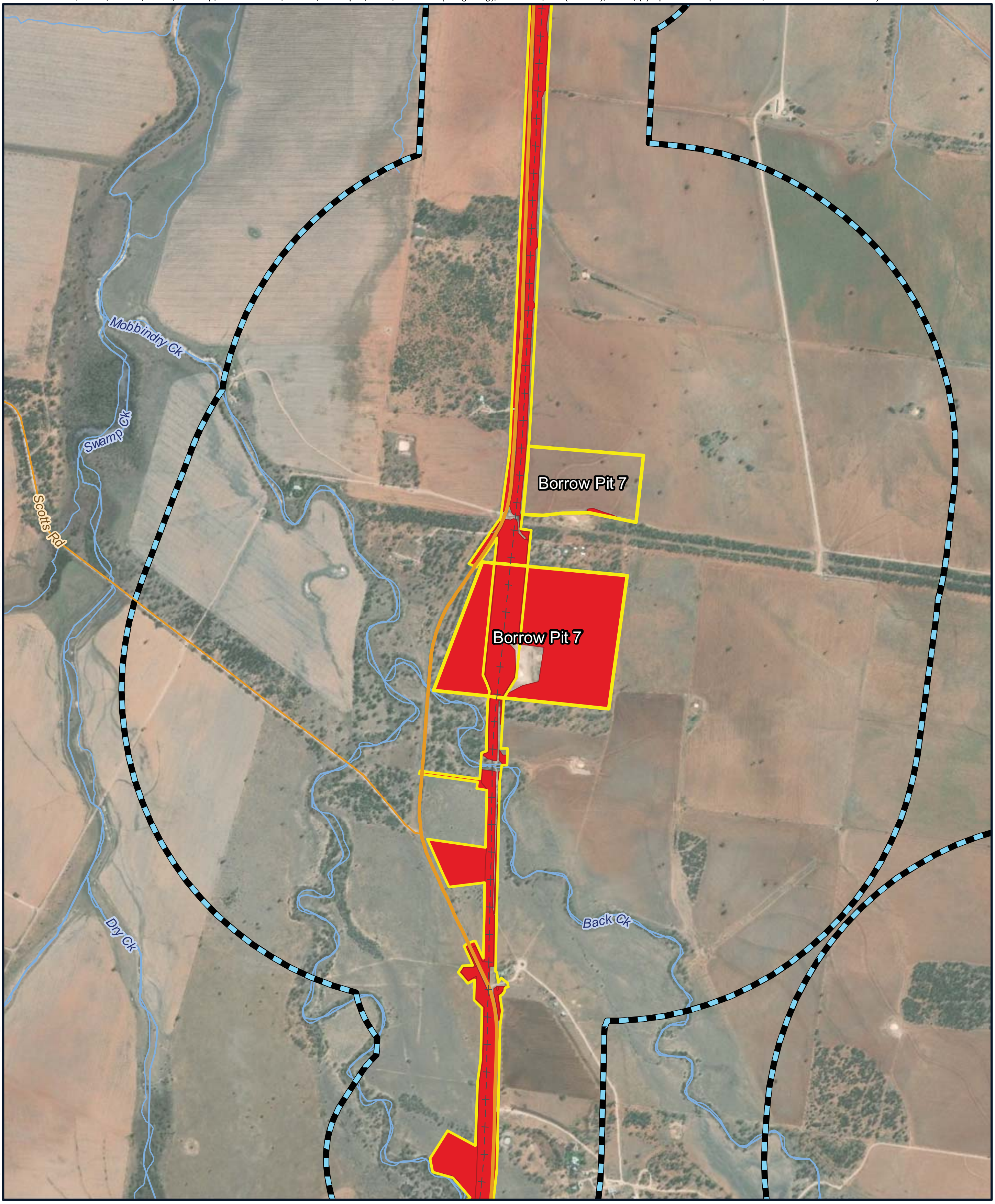
Date: 09/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
***Homopholis belsonii* (Belsons panic)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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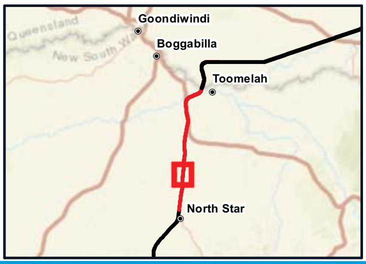
Legend

- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5km

Future Freight

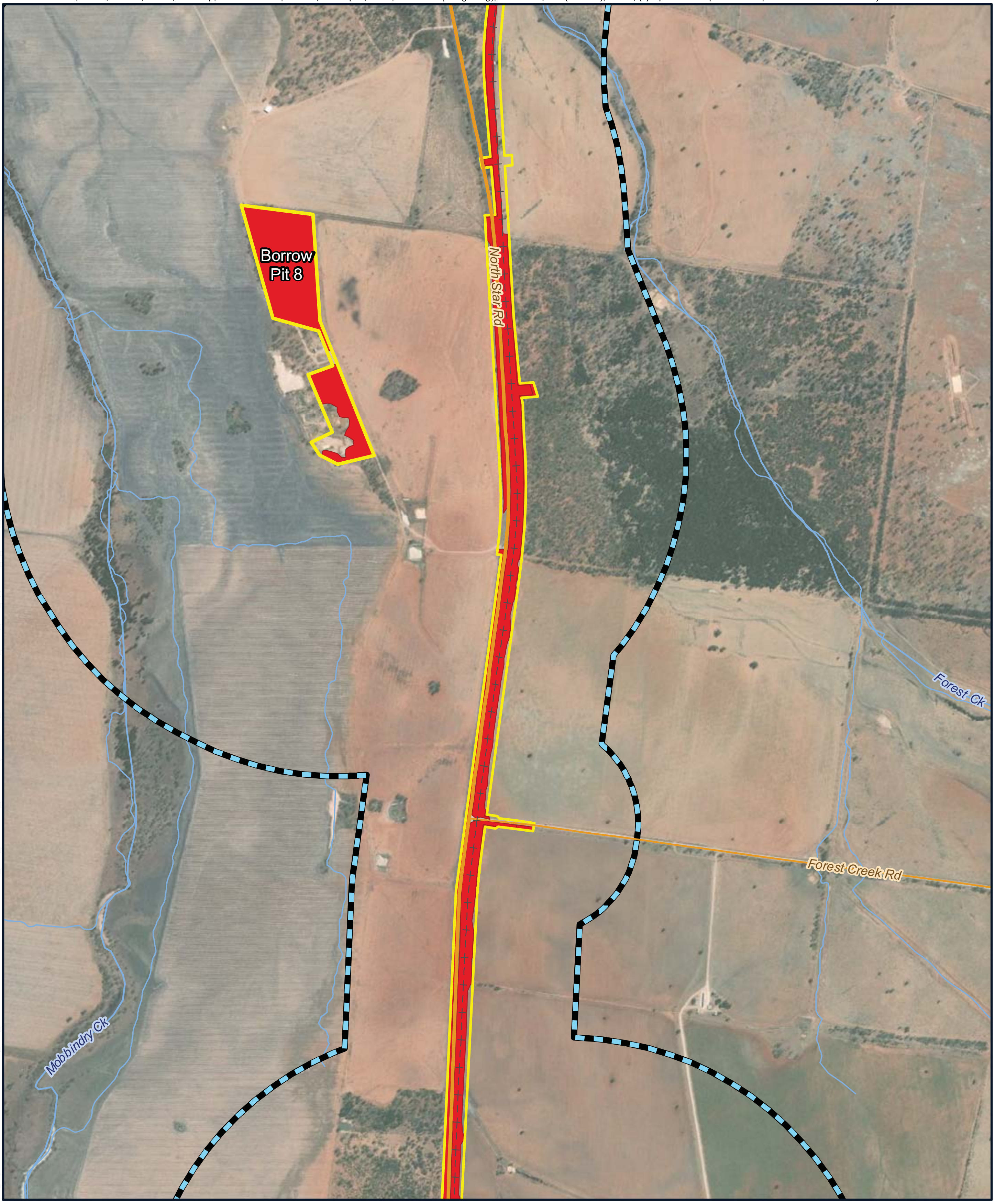
Date: 09/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Homopholis belsonii **(Belsons panic)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5km

Future Freight
Integrating Community, Environment and Engineering

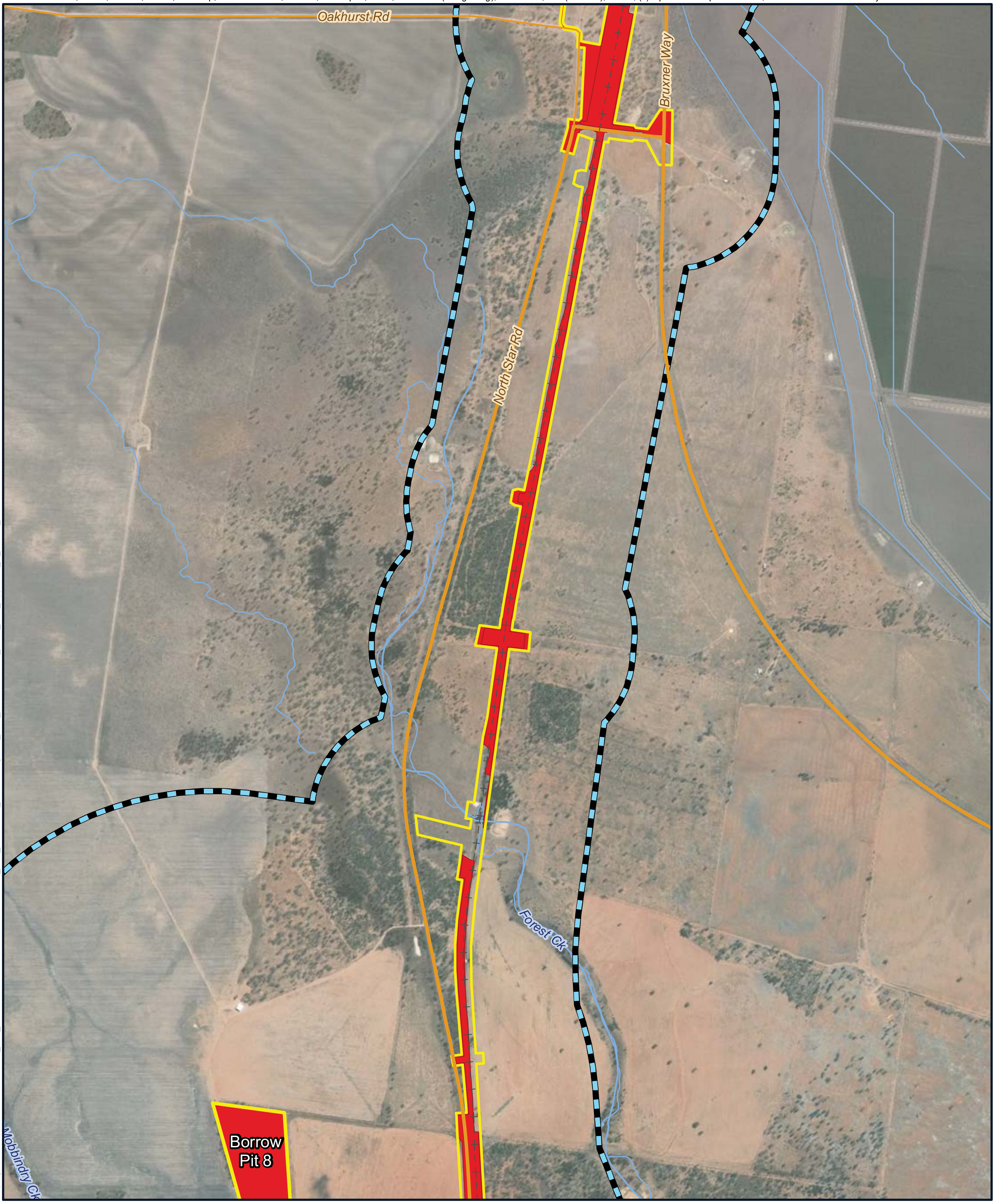
Date: 09/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
***Homopholis belsonii* (Belsons panic)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

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***Homopholis belsonii* (Belsons panic)**

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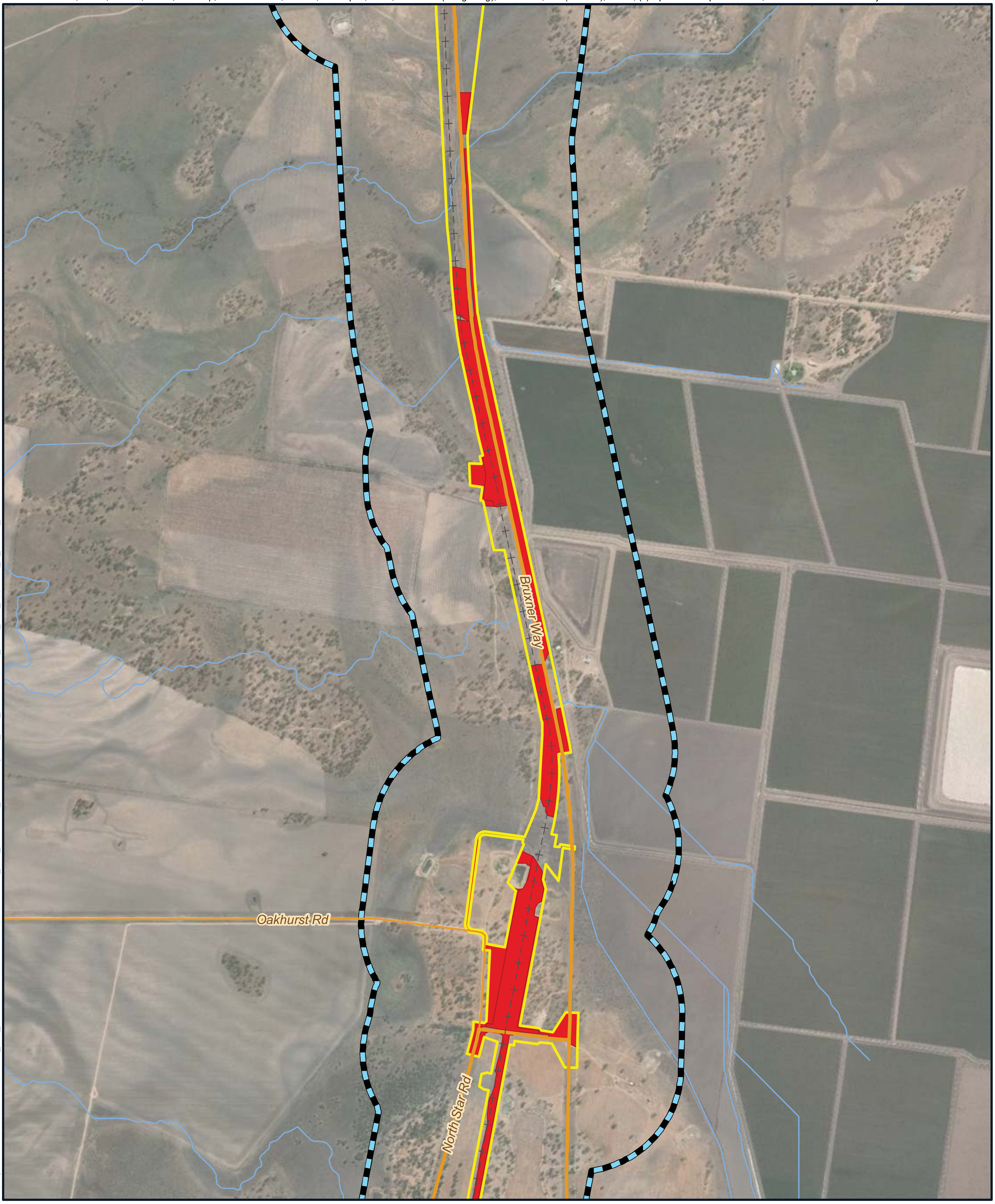

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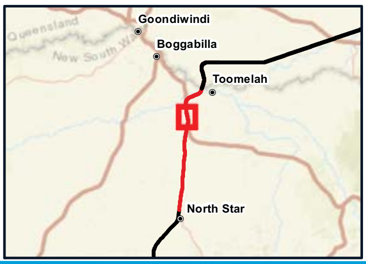
Legend

- Existing rail (non-operational)
- Major roads
- Minor roads
- Study area
- Subject land
- Adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

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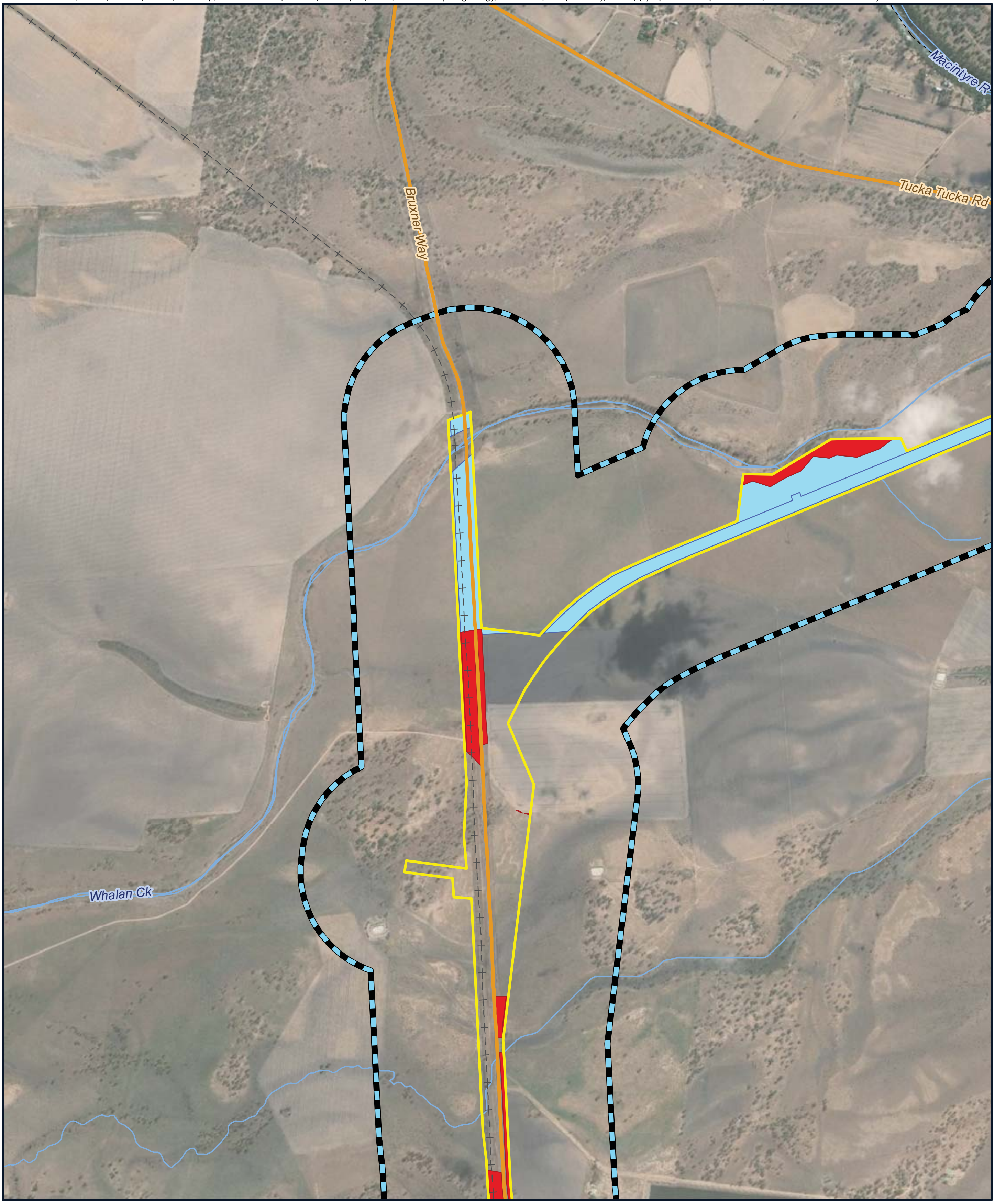

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Legend

- Existing rail (non-operational)
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

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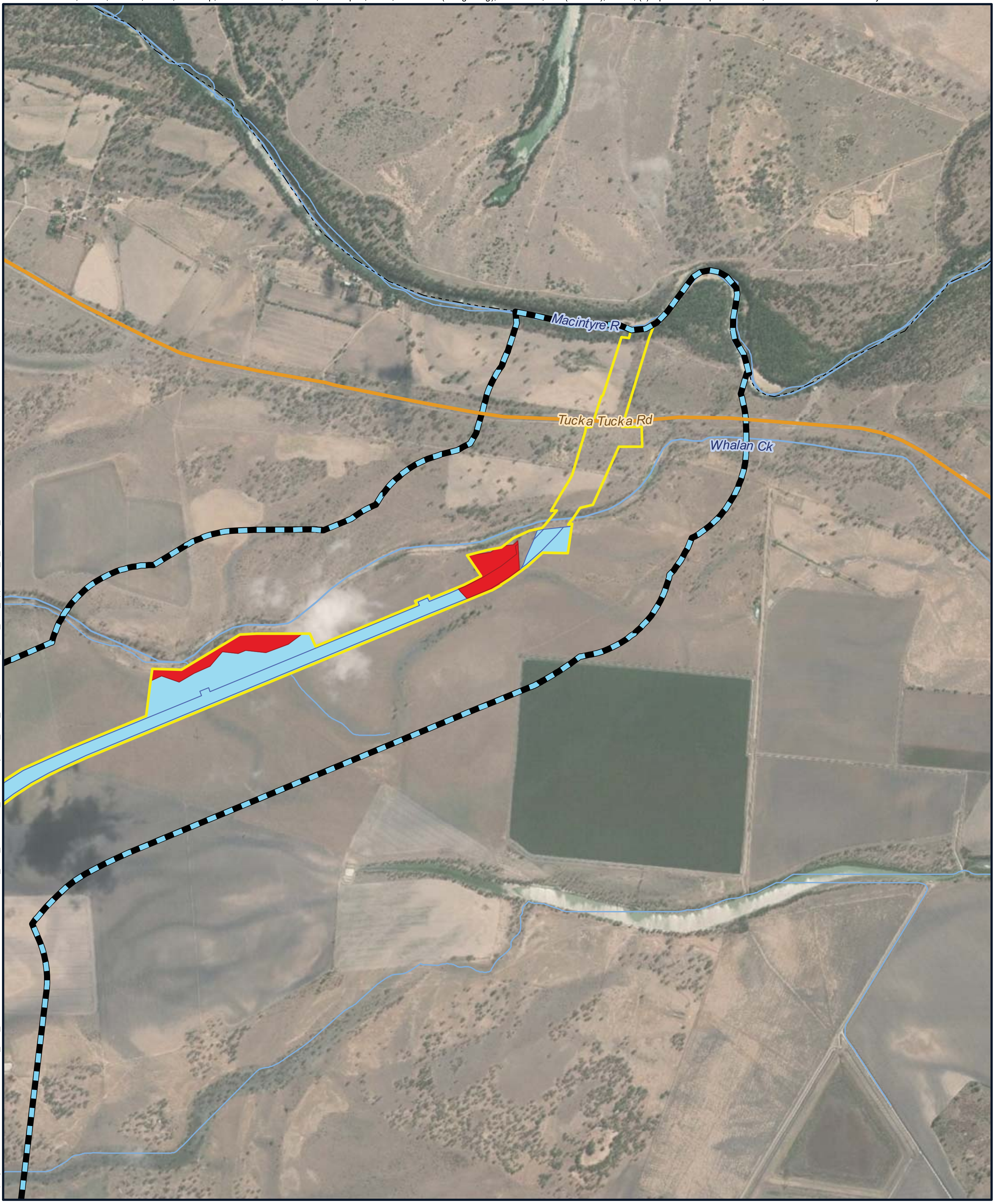

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Legend

- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

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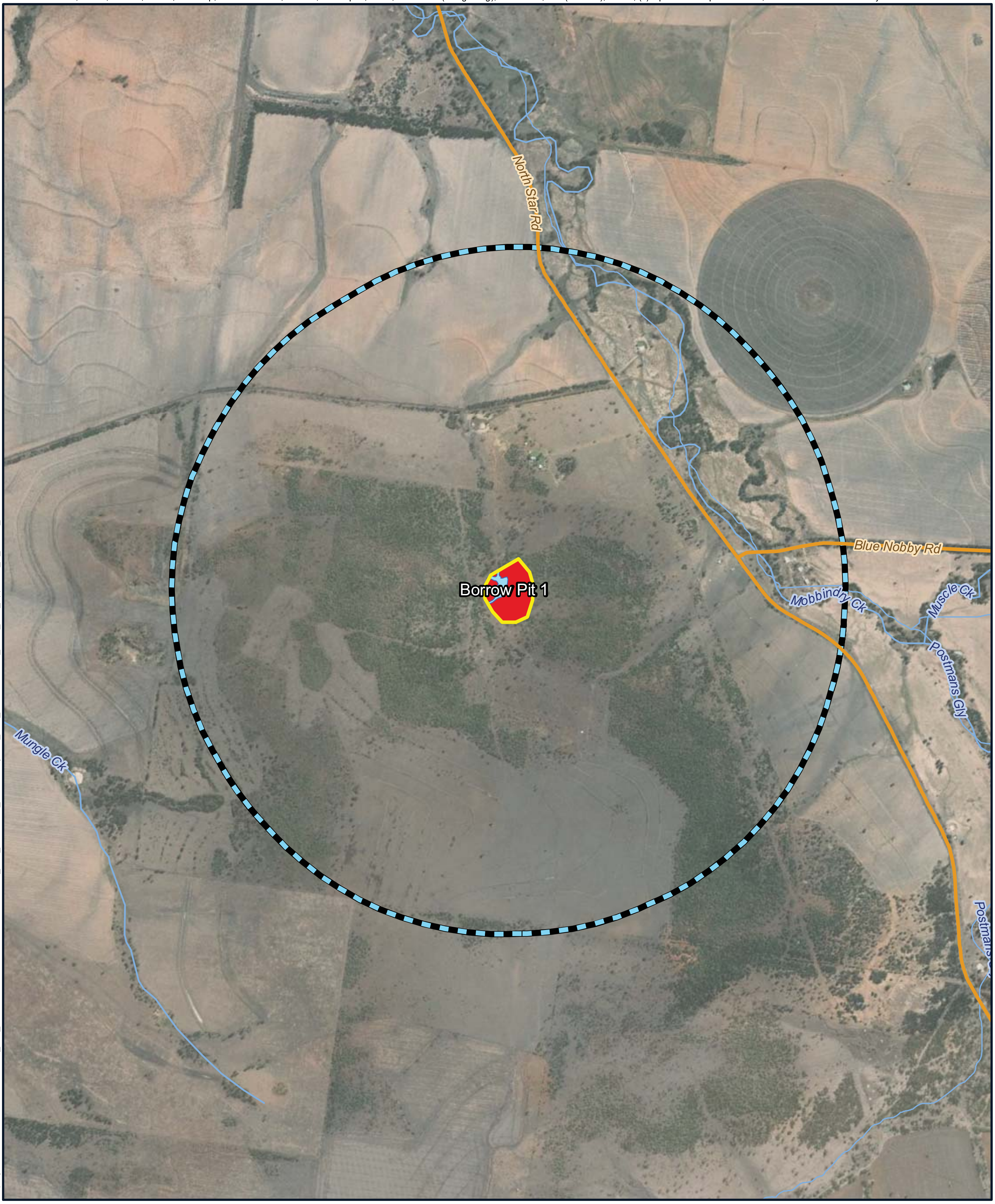

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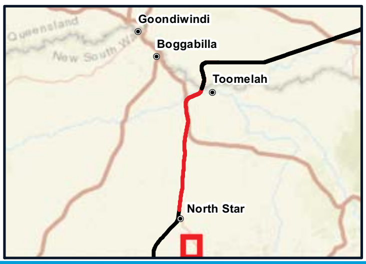
Legend

- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

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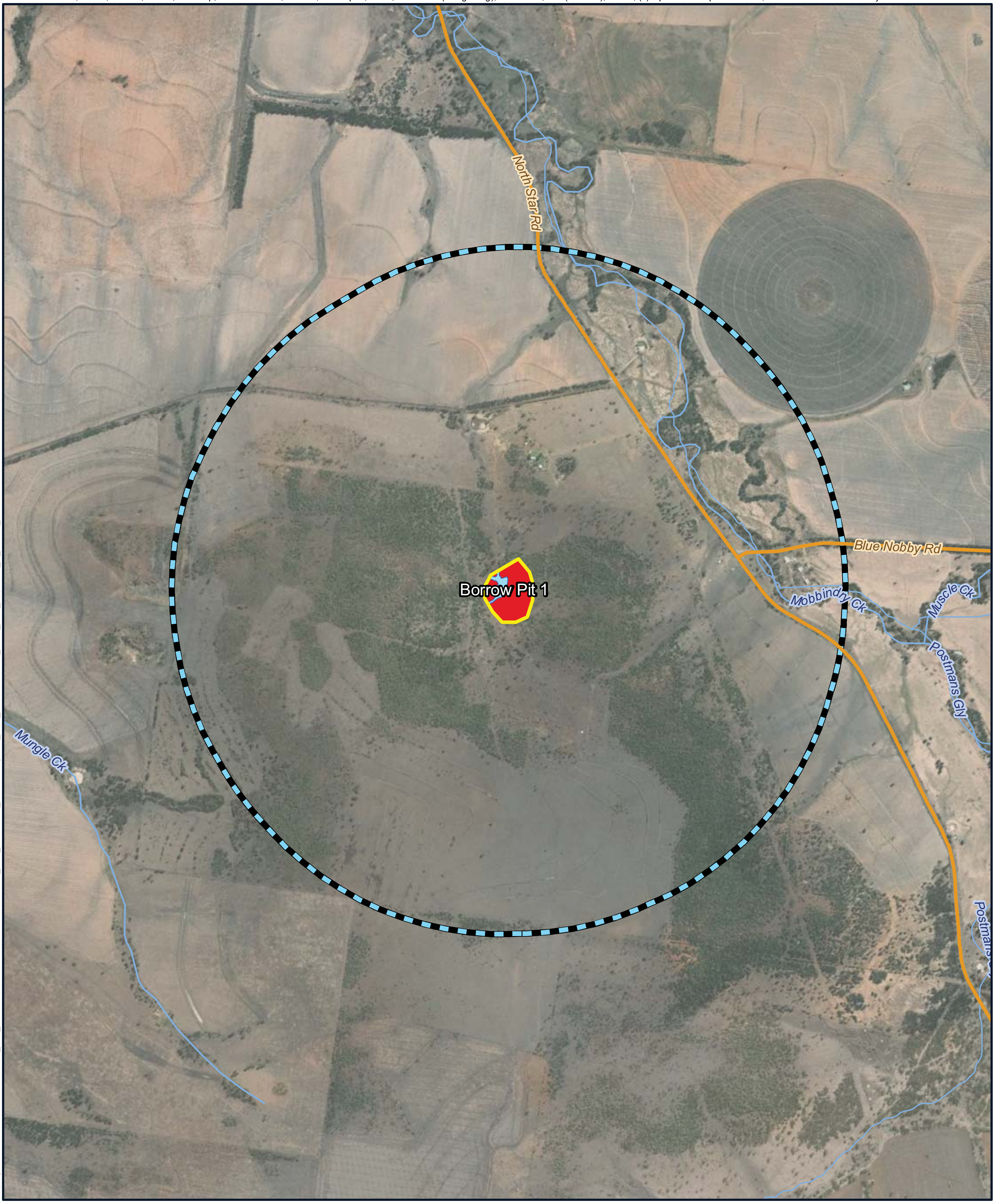

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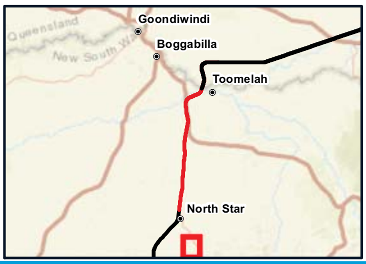
Legend

- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3
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North Star to NSW/QLD border

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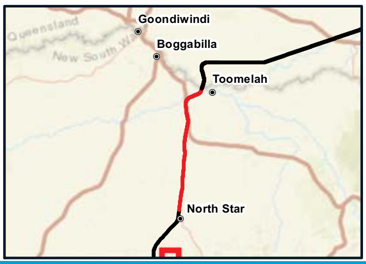
Legend

- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

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Homopholis belsonii **(Belsons panic)**

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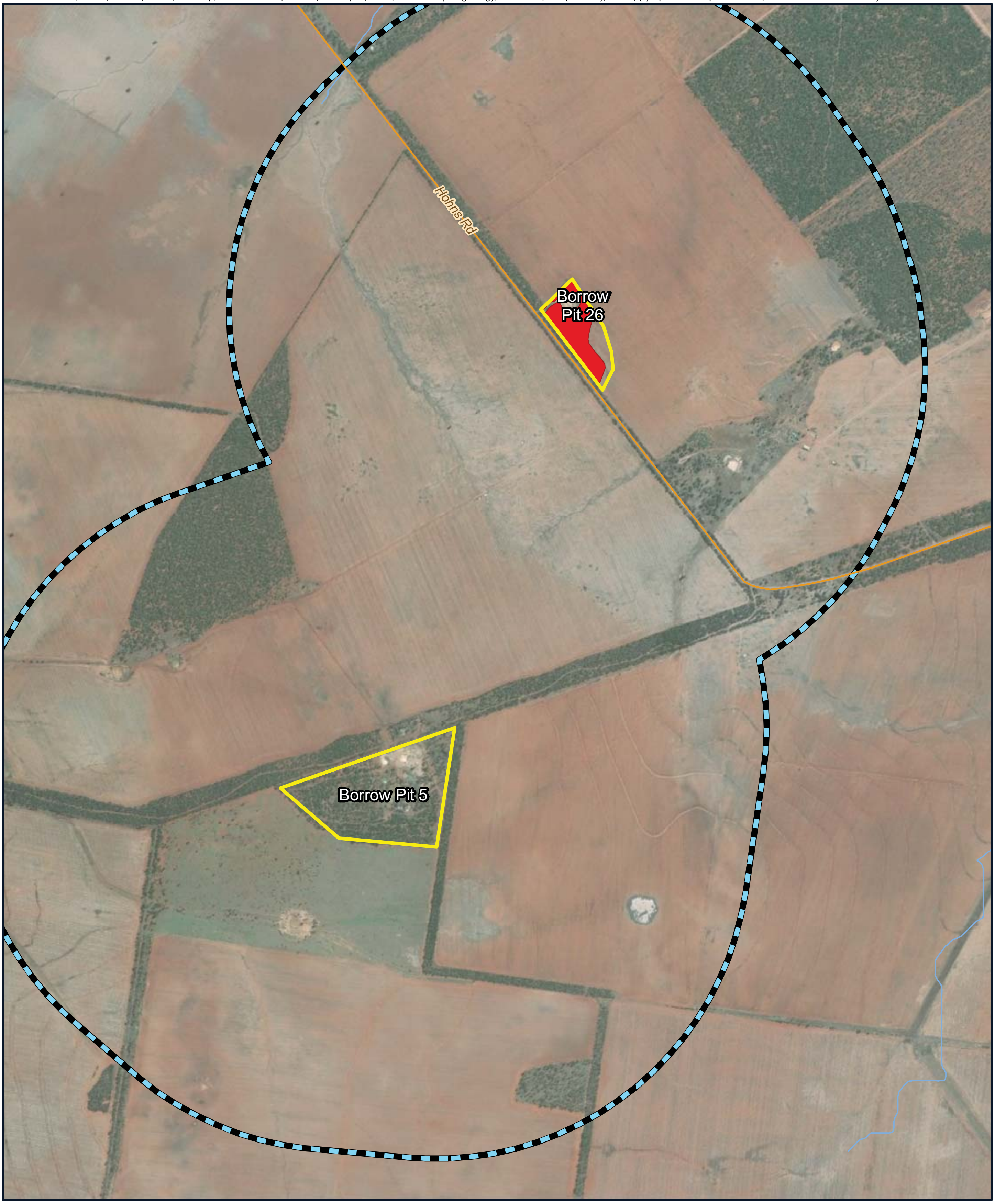

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Legend

Minor roads
Study area
Subject land
Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

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***Homopholis belsonii* (Belsons panic)**

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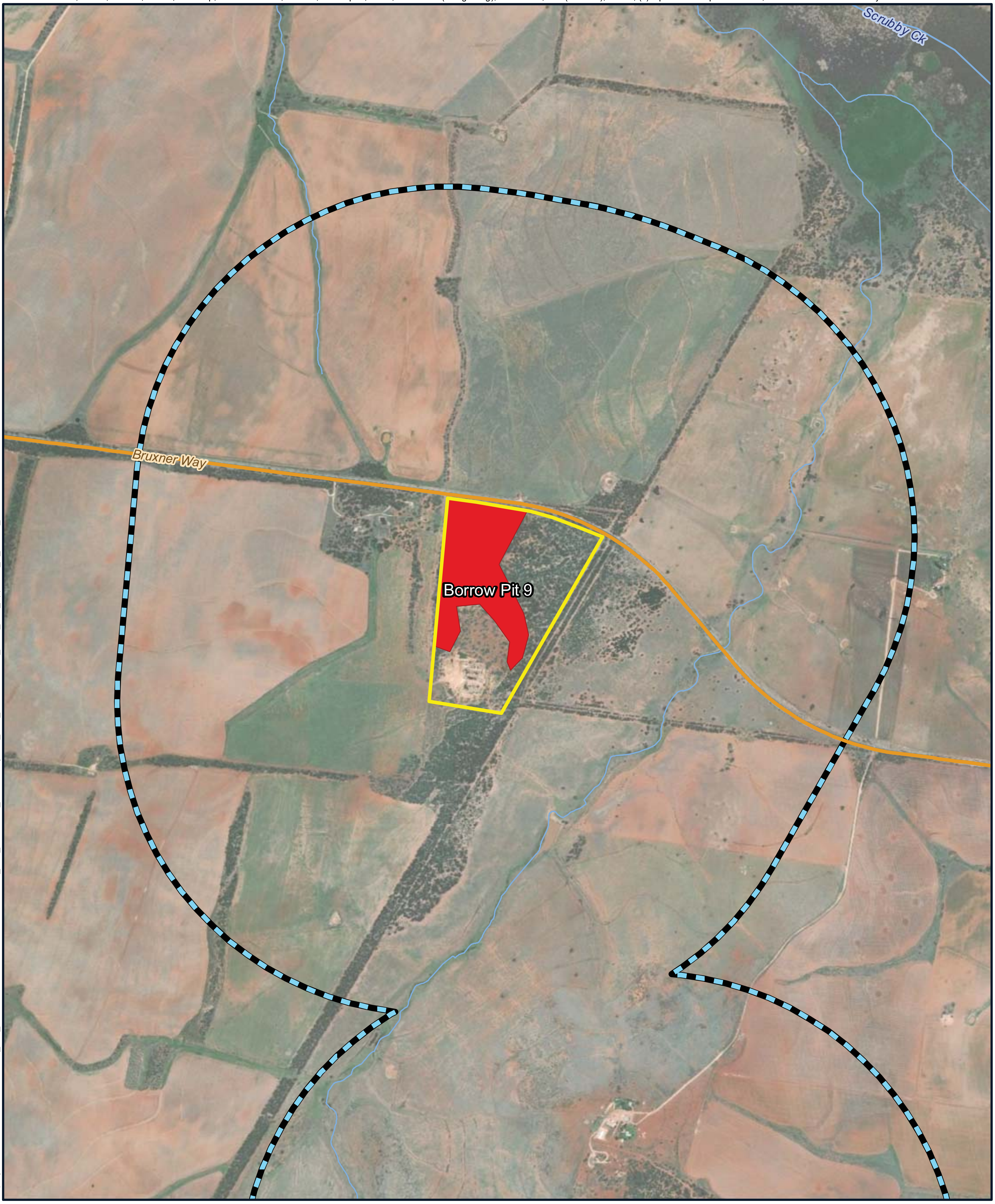

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Legend

- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3

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North Star to NSW/QLD border

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Legend

- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5km

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North Star to NSW/QLD border

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Legend

Major roads
Minor roads
Watercourses
Study area
Subject land
Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

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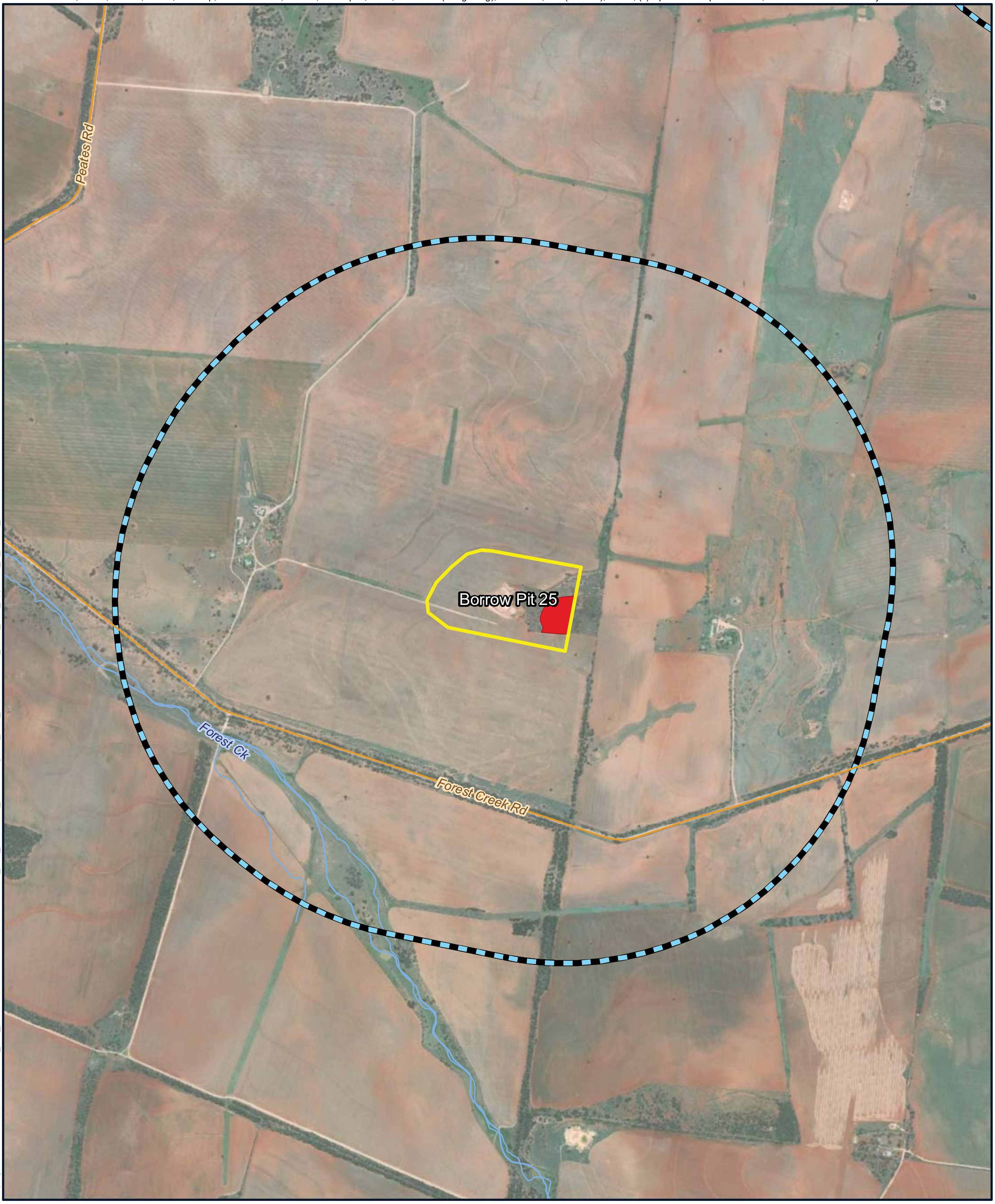

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Legend

- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
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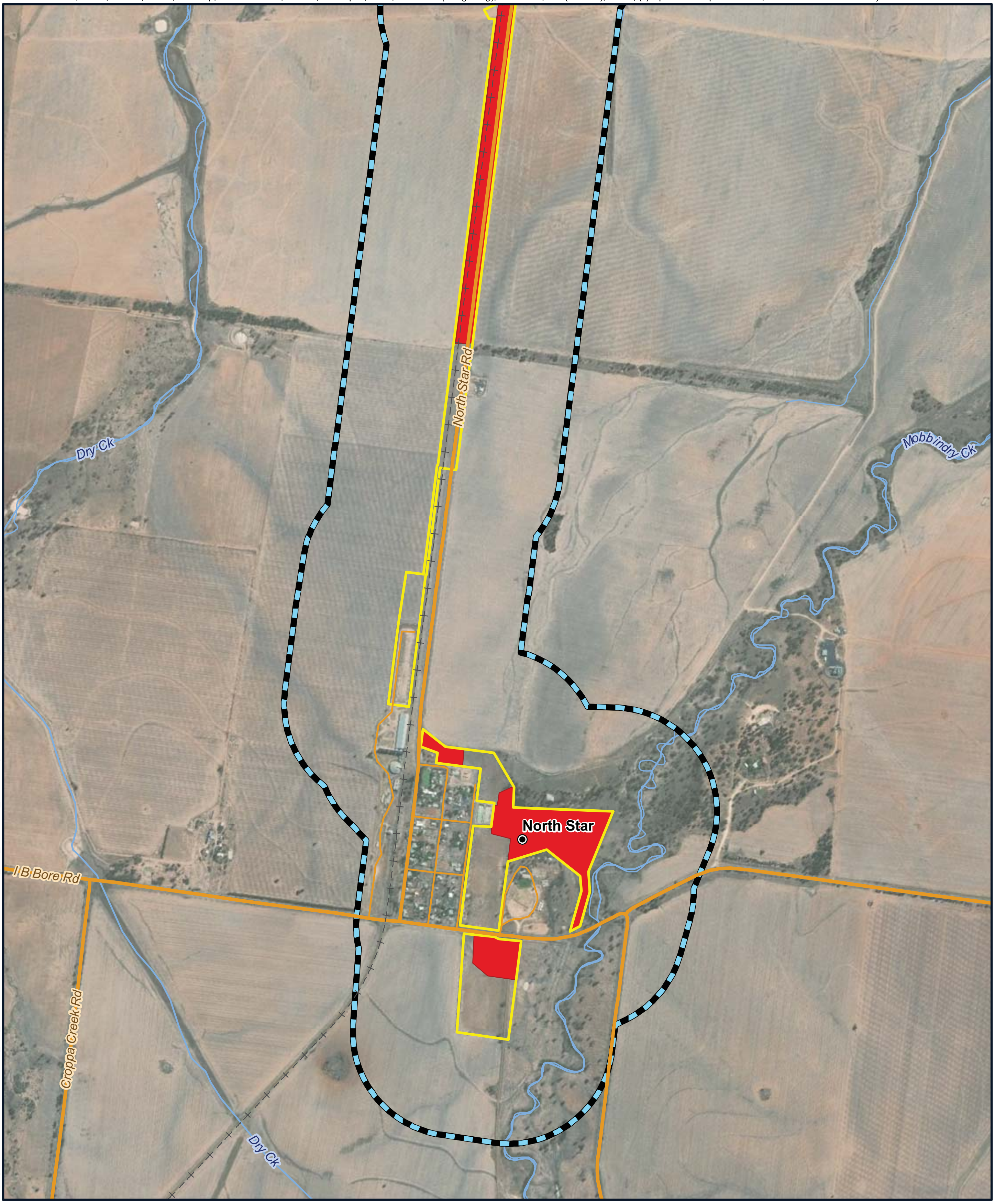

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Legend

- Localities
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
***Swainsona murrayana* (Slender darling-pea)**

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Legend

- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

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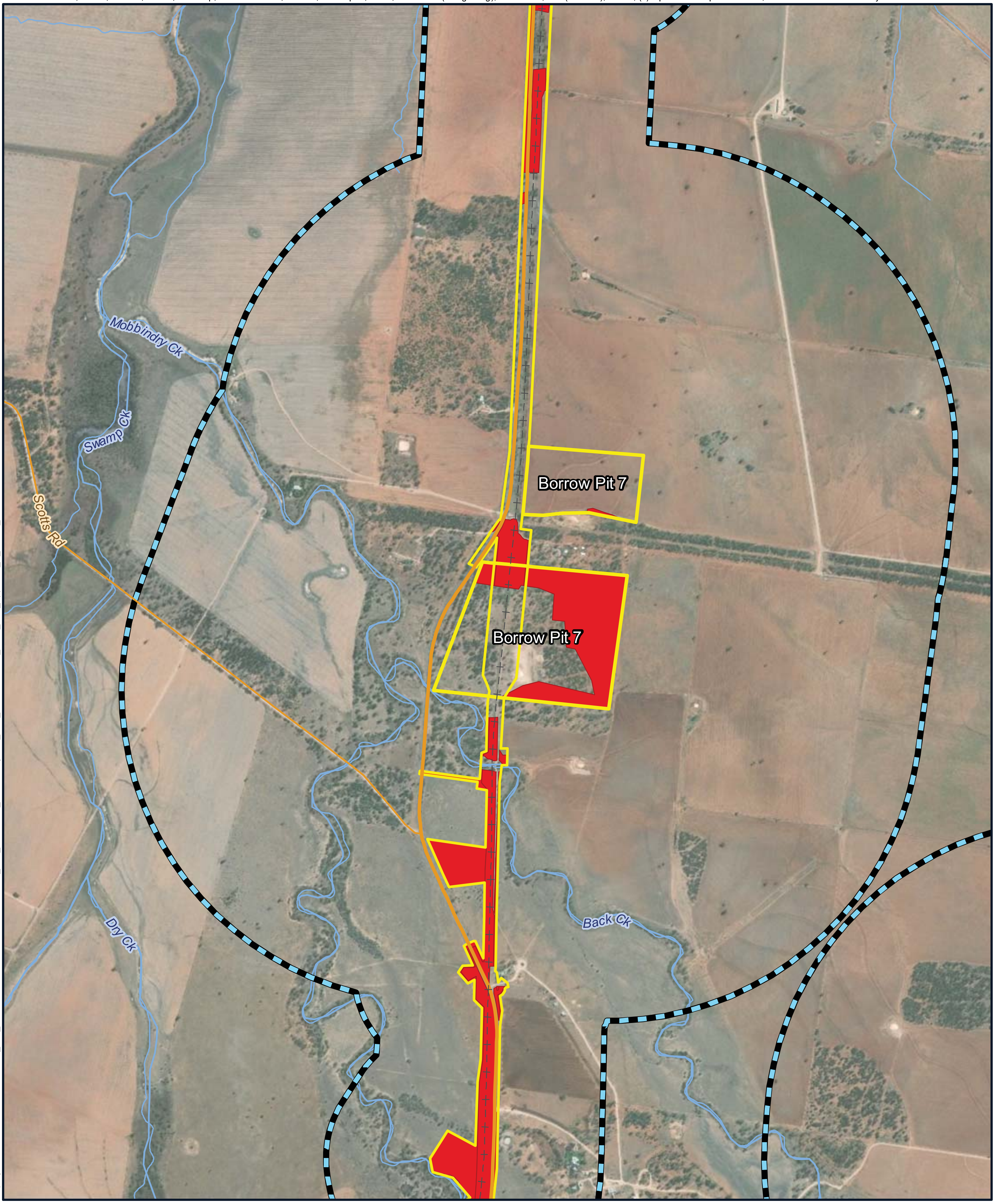

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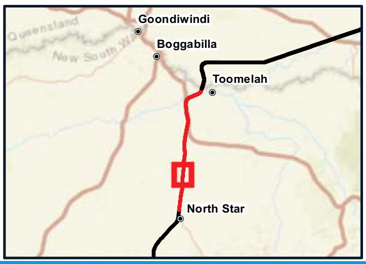
Legend

- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

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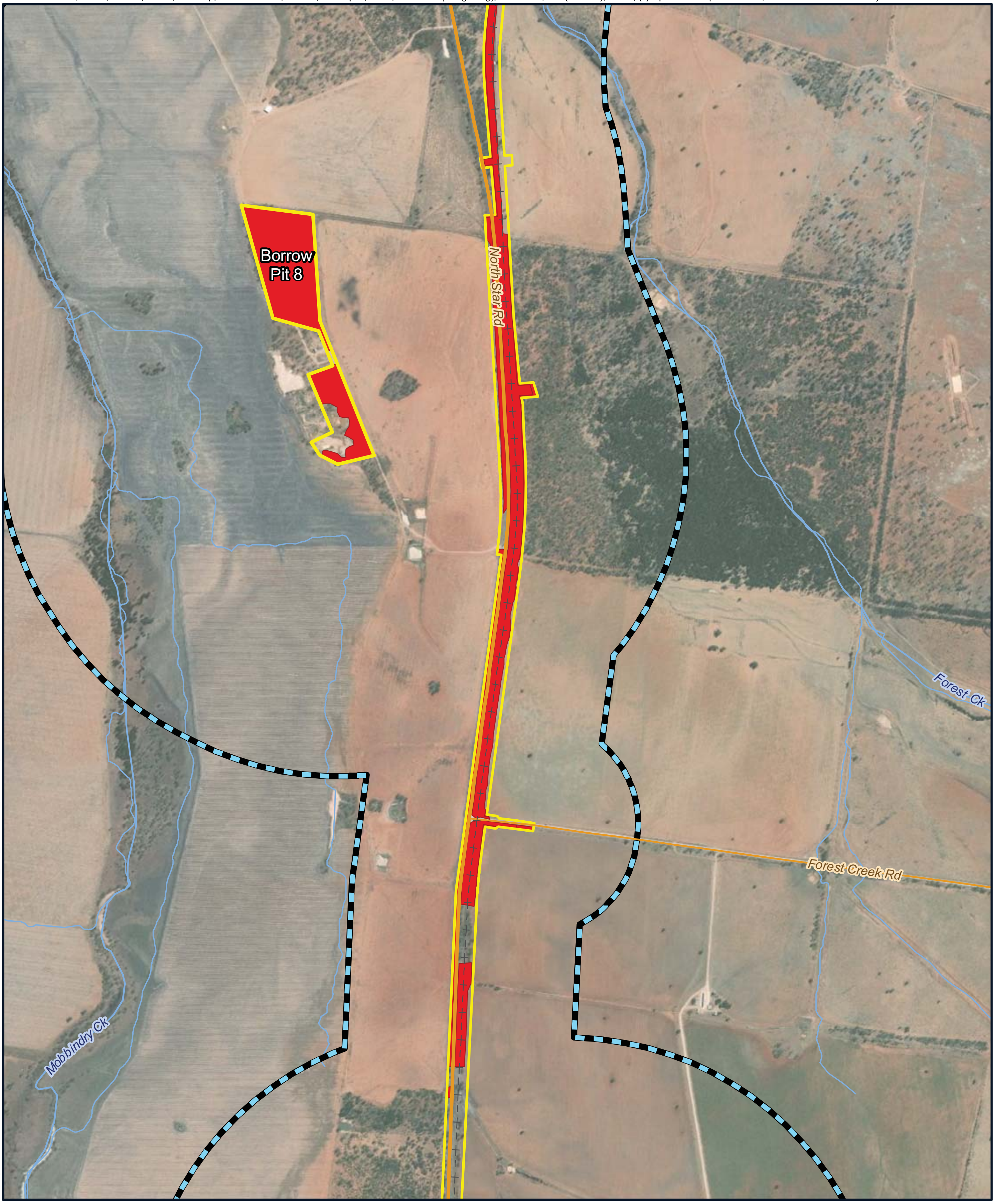

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Legend

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- Minor roads
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- Study area
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0 0.1 0.2 0.3 0.4 0.5 km

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North Star to NSW/QLD border

Appendix C AIAMs output:
***Swainsona murrayana* (Slender darling-pea)**

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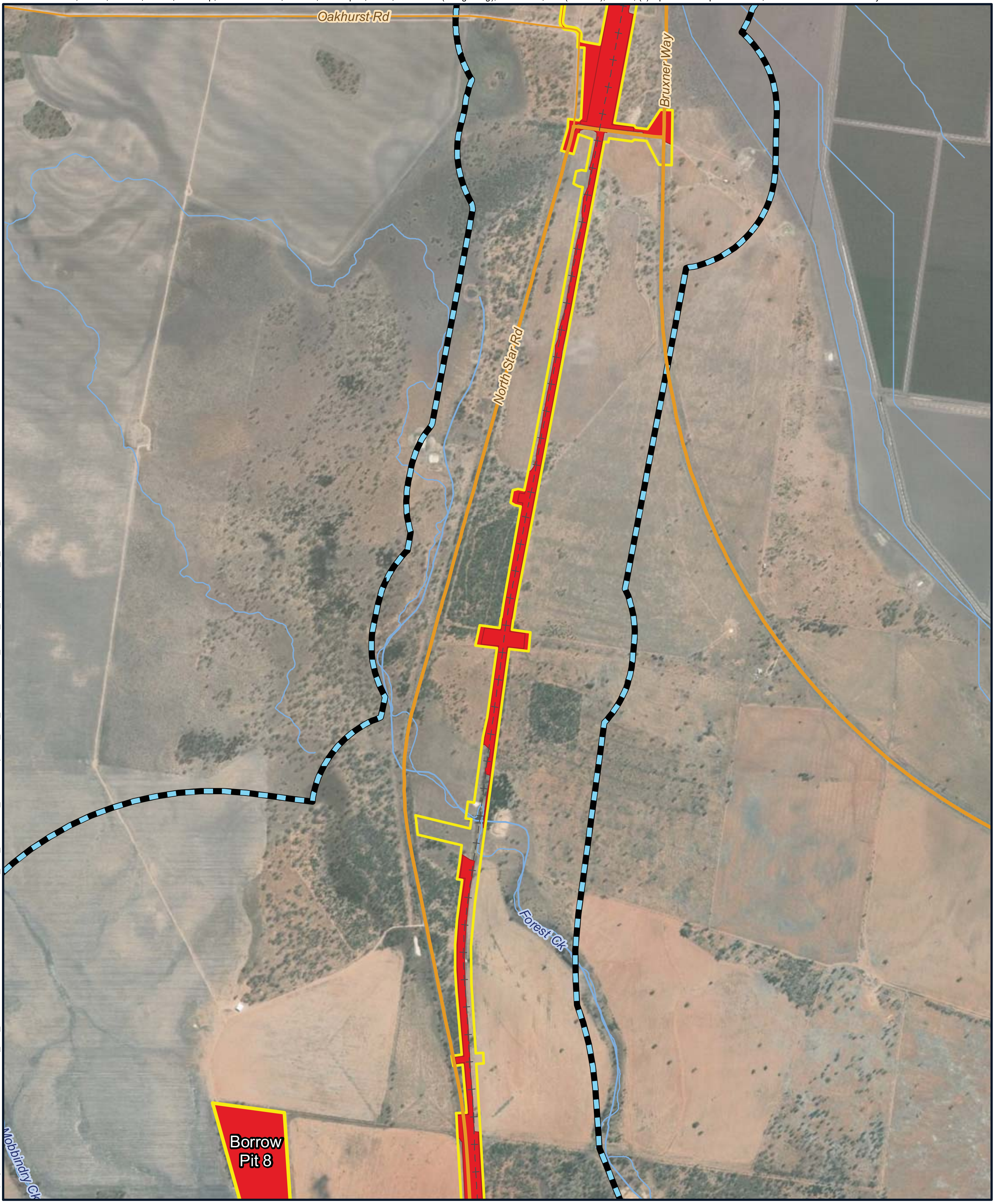

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Legend

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- Minor roads
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0 0.1 0.2 0.3 0.4 0.5 km

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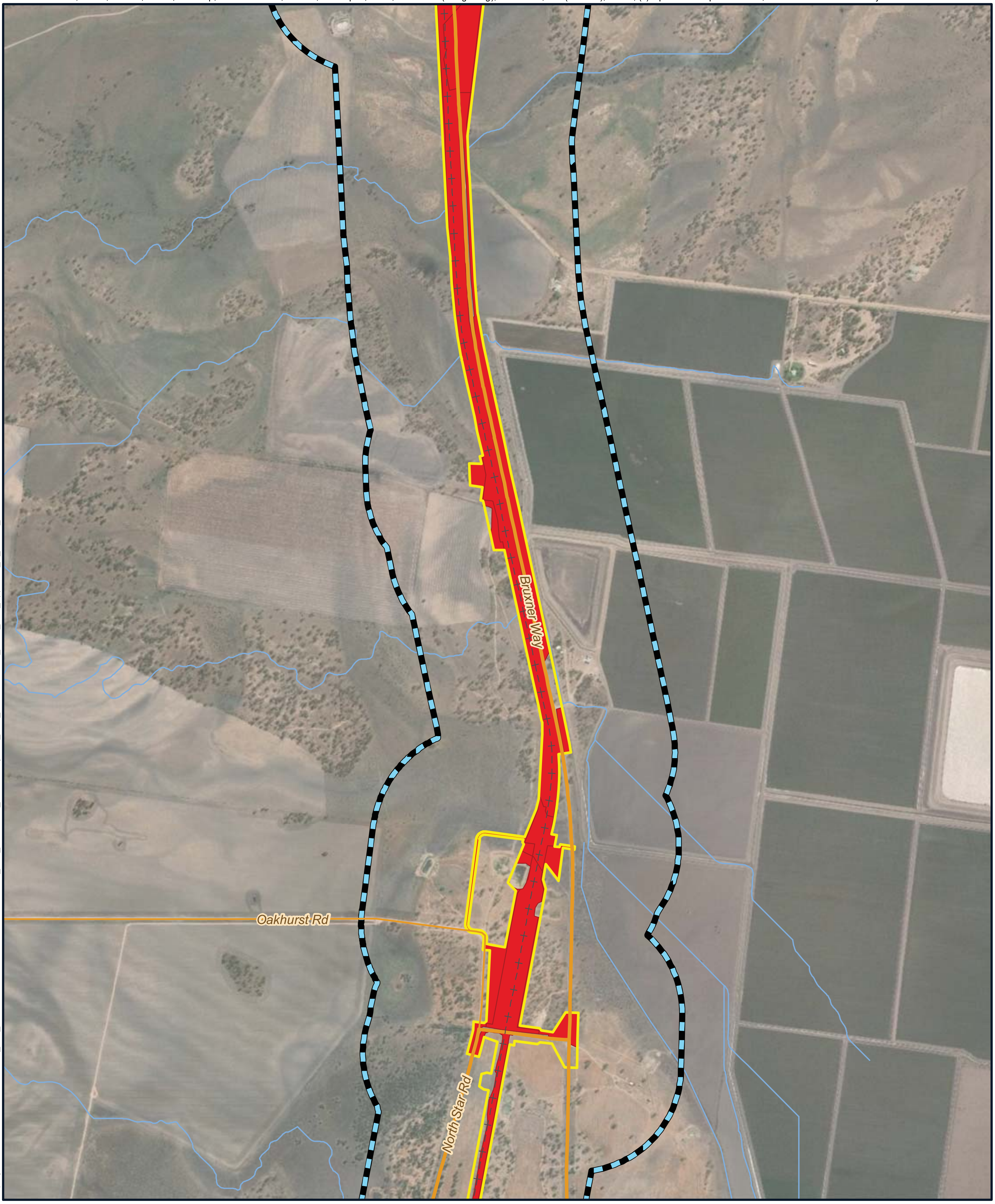

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Legend

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0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
***Swainsona murrayana* (Slender darling-pea)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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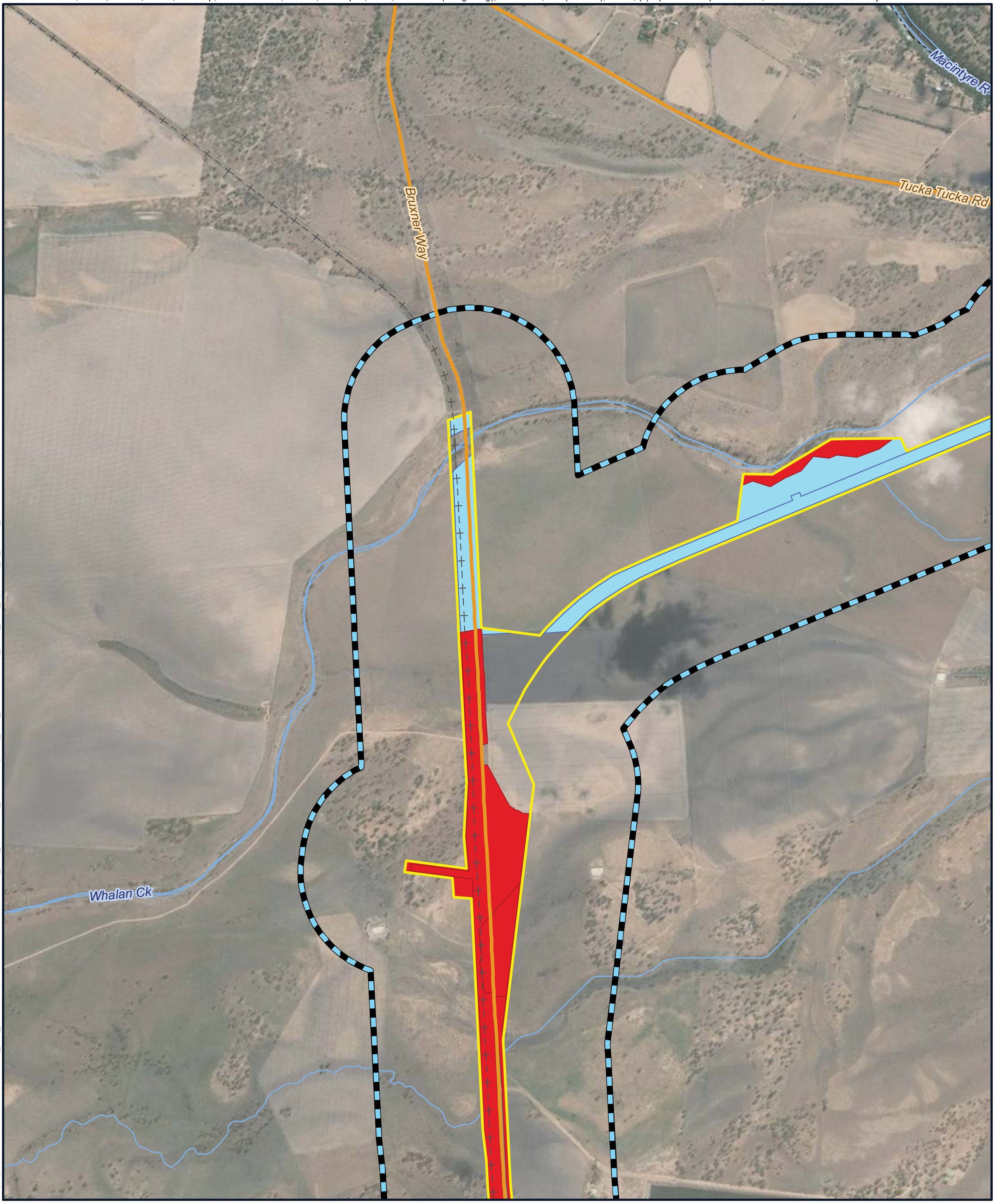

Legend

- Existing rail (non-operational)
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
***Swainsona murrayana* (Slender darling-pea)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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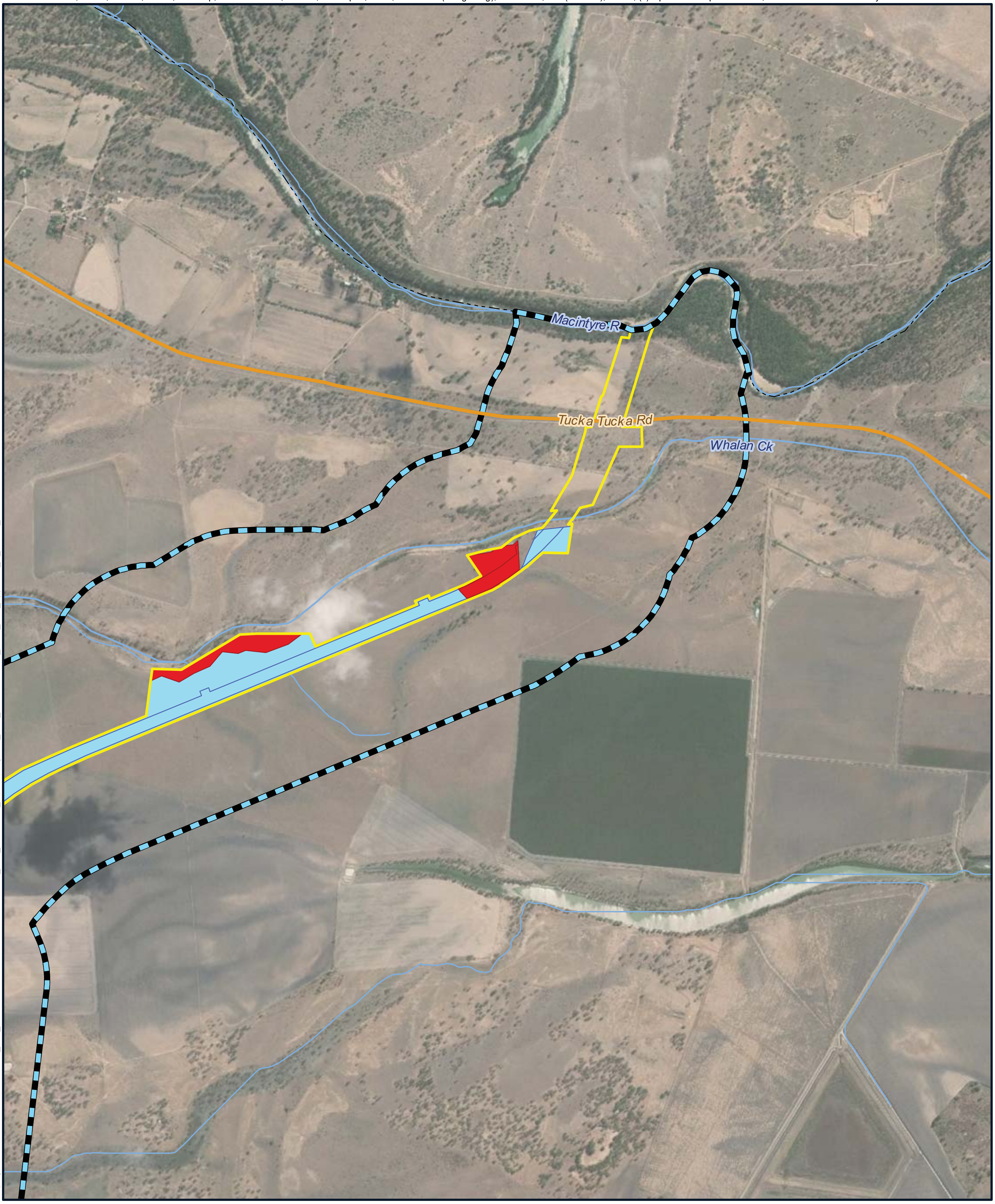


Legend

- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
***Swainsona murrayana* (Slender darling-pea)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

Map by: RB/MF/DTH/MF Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-202007011428_GIS_Terrestrial_biodiversity\270_EAP_202007011428_FFJV_A4P_Appendix_C_AIAMs_Flora.mxd Date: 21/07/2020 17:07

Legend

Minor roads
Study area
Subject land
Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

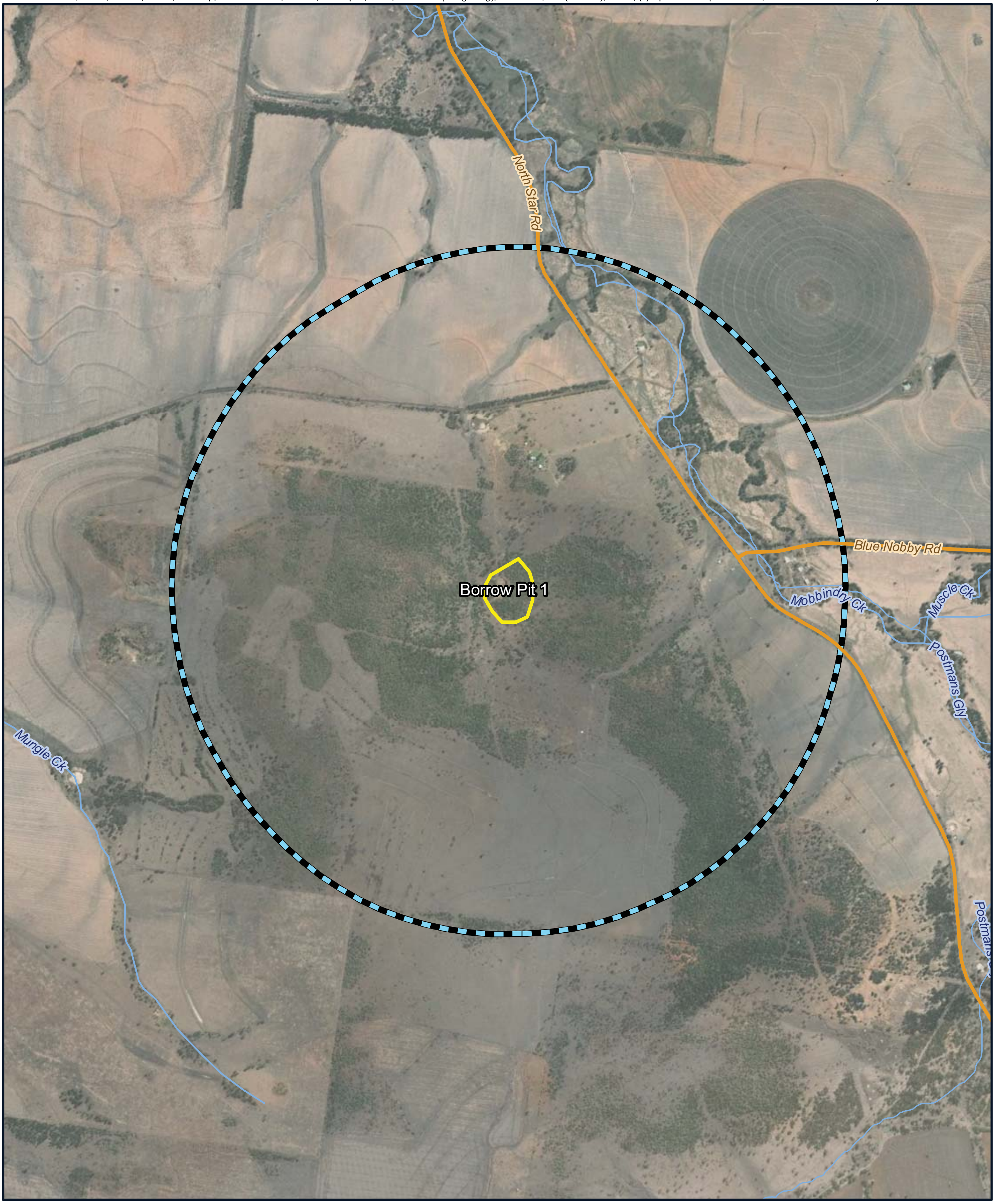
Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
***Swainsona murrayana* (Slender darling-pea)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
***Tylophora linearis* (Slender tylophora)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

Map by: RB/MF/DTH/MF Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-202007011428_GIS_Terrestrial_biodiversity\270_EAP_202007011428_FFJV_A4P_Appendix_C_AIAMs_Flora.mxd Date: 21/07/2020 17:07

Legend

- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5km

Future Freight

Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3

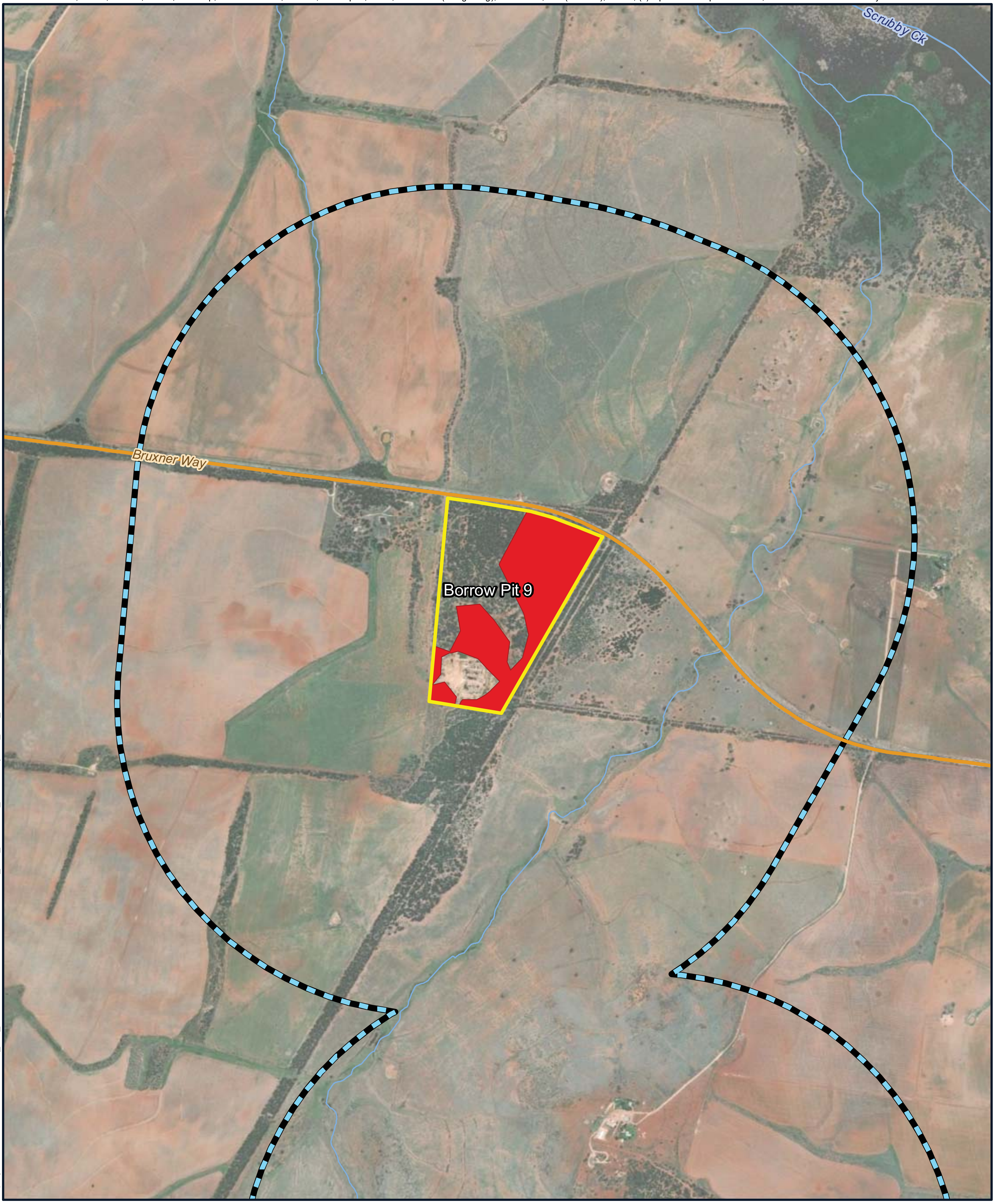
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:

Tylophora linearis **(Slender tylophora)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
***Tylophora linearis* (Slender tylophora)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

Map by: RB/MF/DTH/MF Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-202007011428_GIS_Terrestrial_biodiversity\270_EAP_202007011428_FFJV_A4P_Appendix_C_AIAMs_Flora.mxd Date: 21/07/2020 17:07

Legend

- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

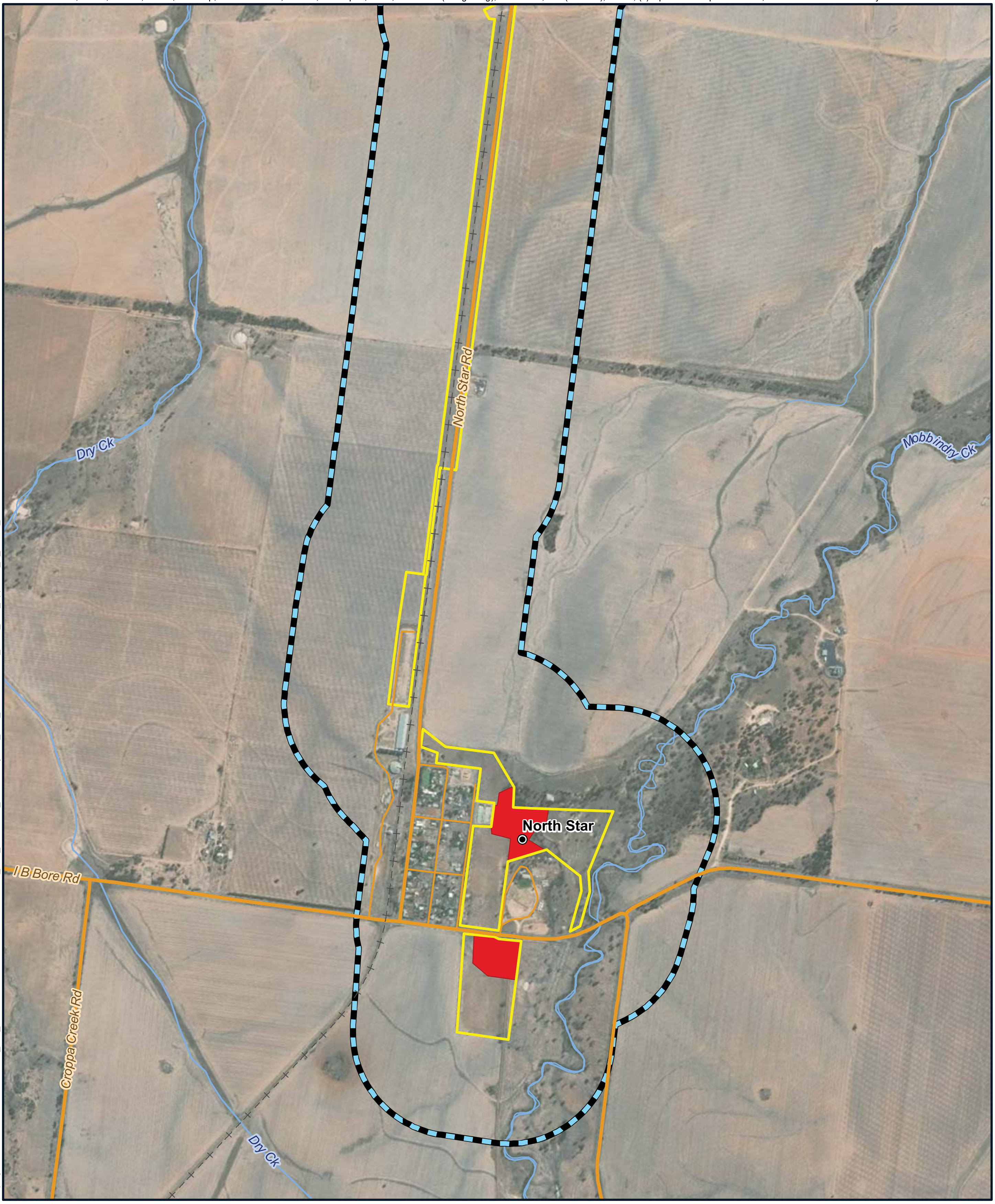
Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
***Tylophora linearis* (Slender tylophora)**

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Localities
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Five-clawed worm-skink (*Anomalopus mackayi*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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Legend

- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

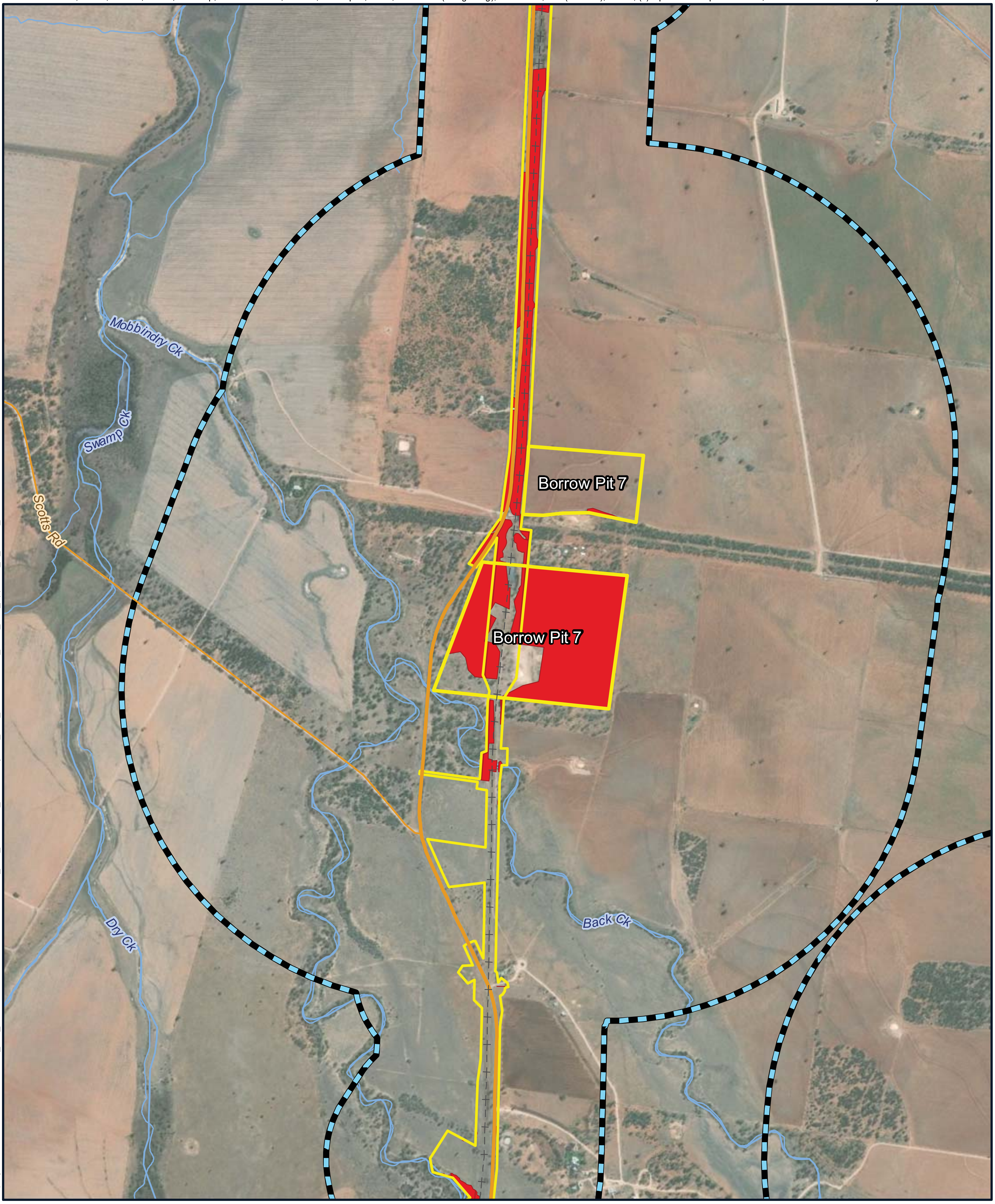
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Five-clawed worm-skink (*Anomalopus mackayi*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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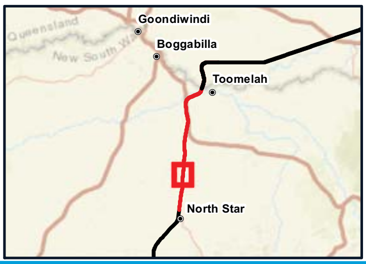
Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight

Integrating Community, Environment and Engineering

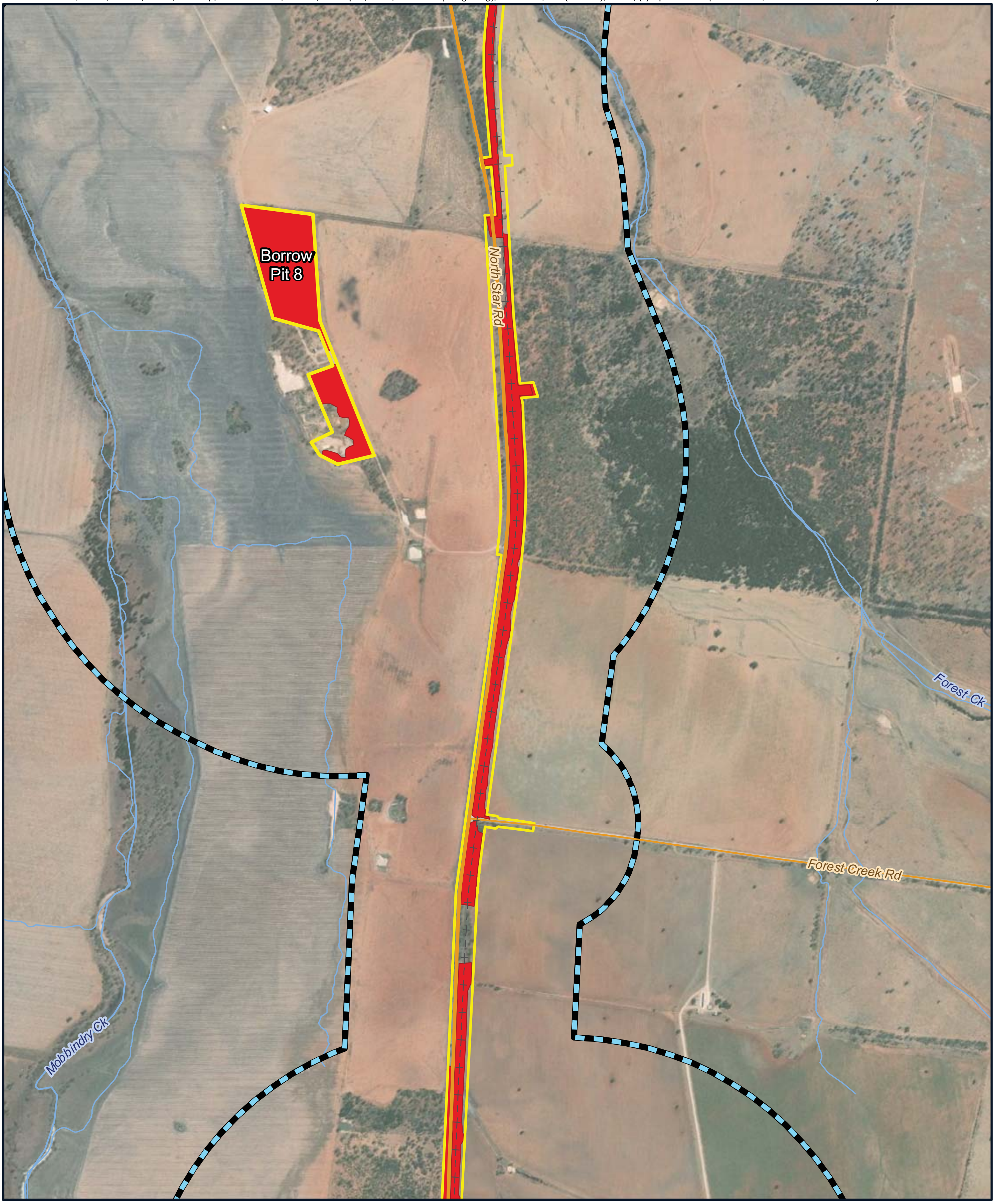
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Five-clawed worm-skink (*Anomalopus mackayi*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

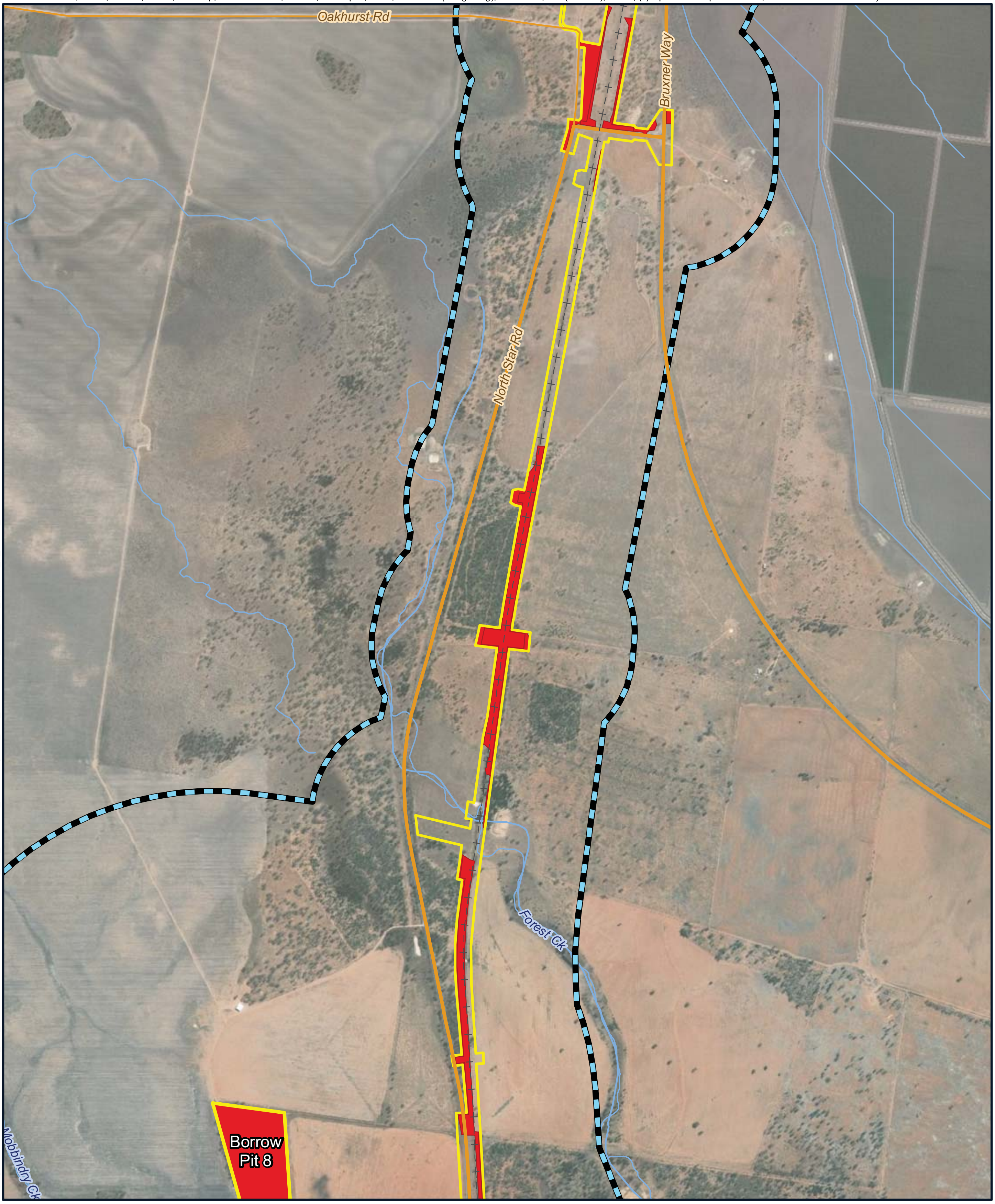
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Five-clawed worm-skink (*Anomalopus mackayi*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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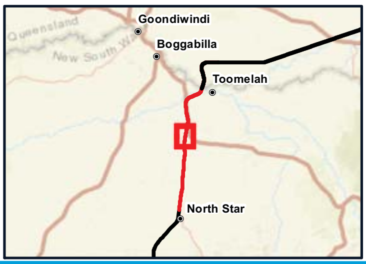
Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

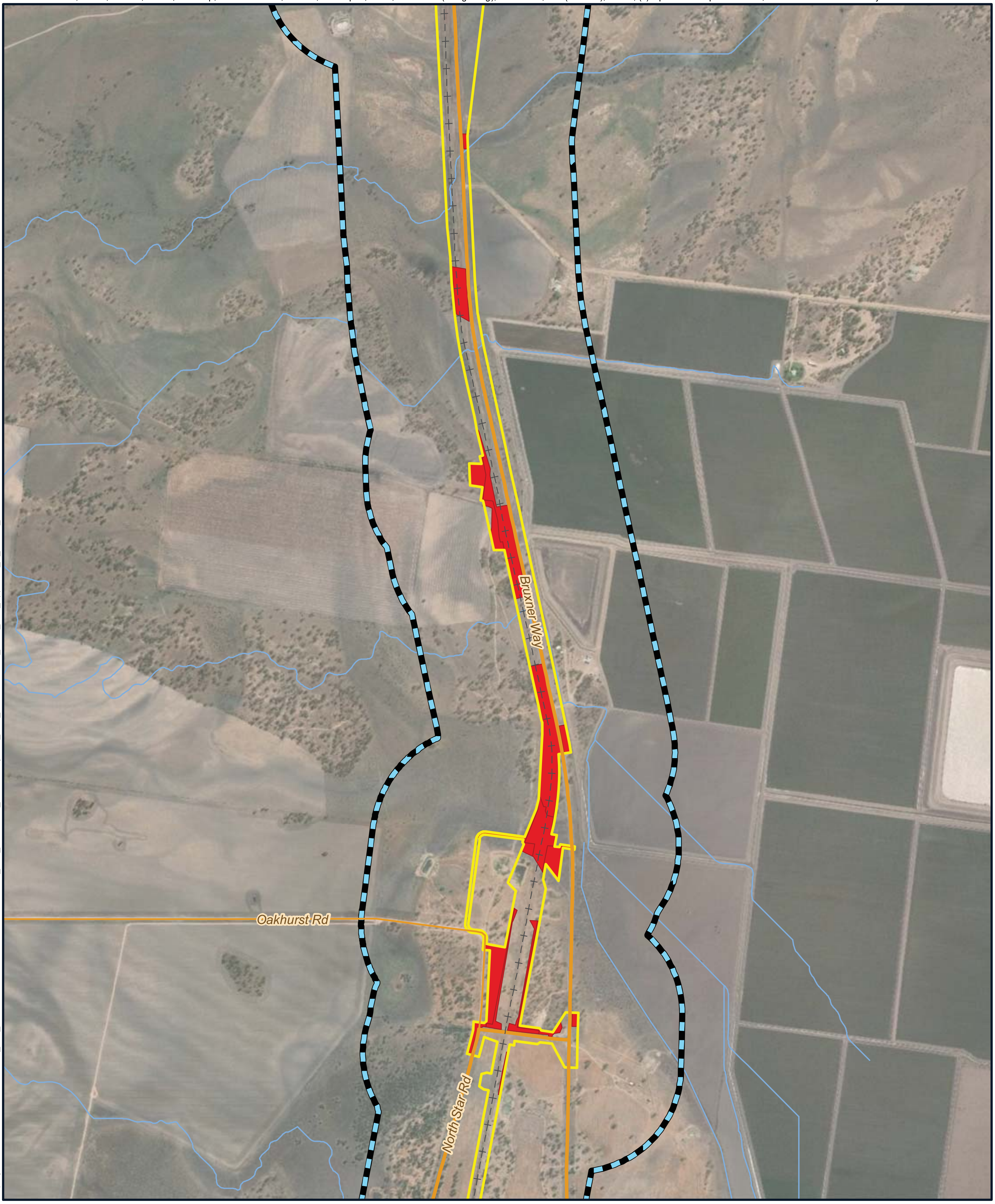
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Five-clawed worm-skink (*Anomalopus mackayi*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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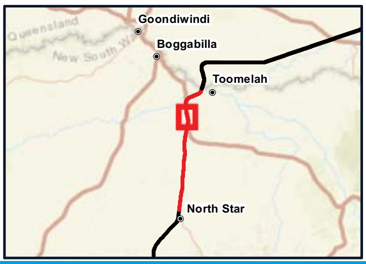
Legend

- Existing rail (non-operational)
- Major roads
- Minor roads
- Study area
- Subject land
- Adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

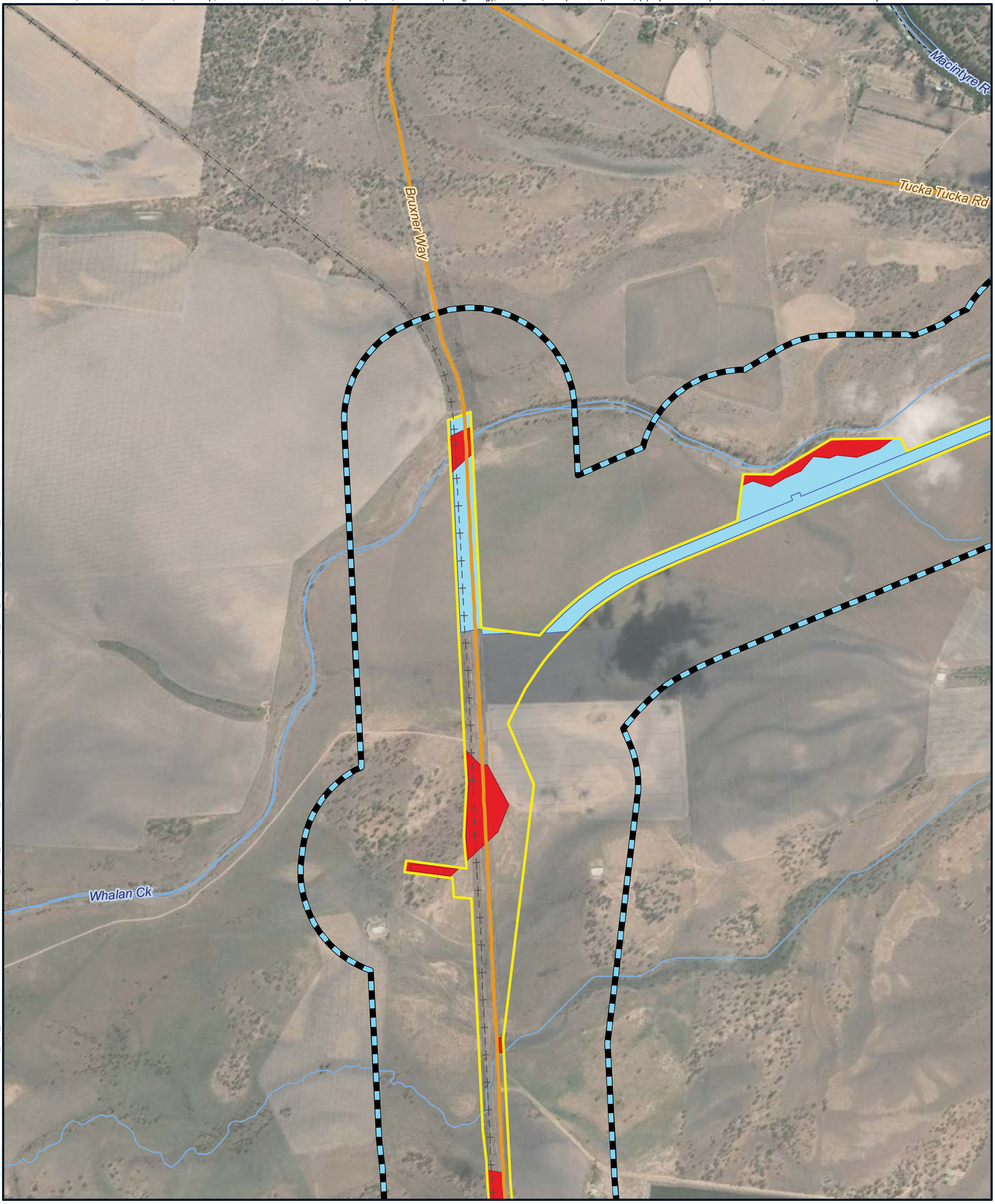
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Five-clawed worm-skink (*Anomalopus mackayi*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Existing rail (non-operational)
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

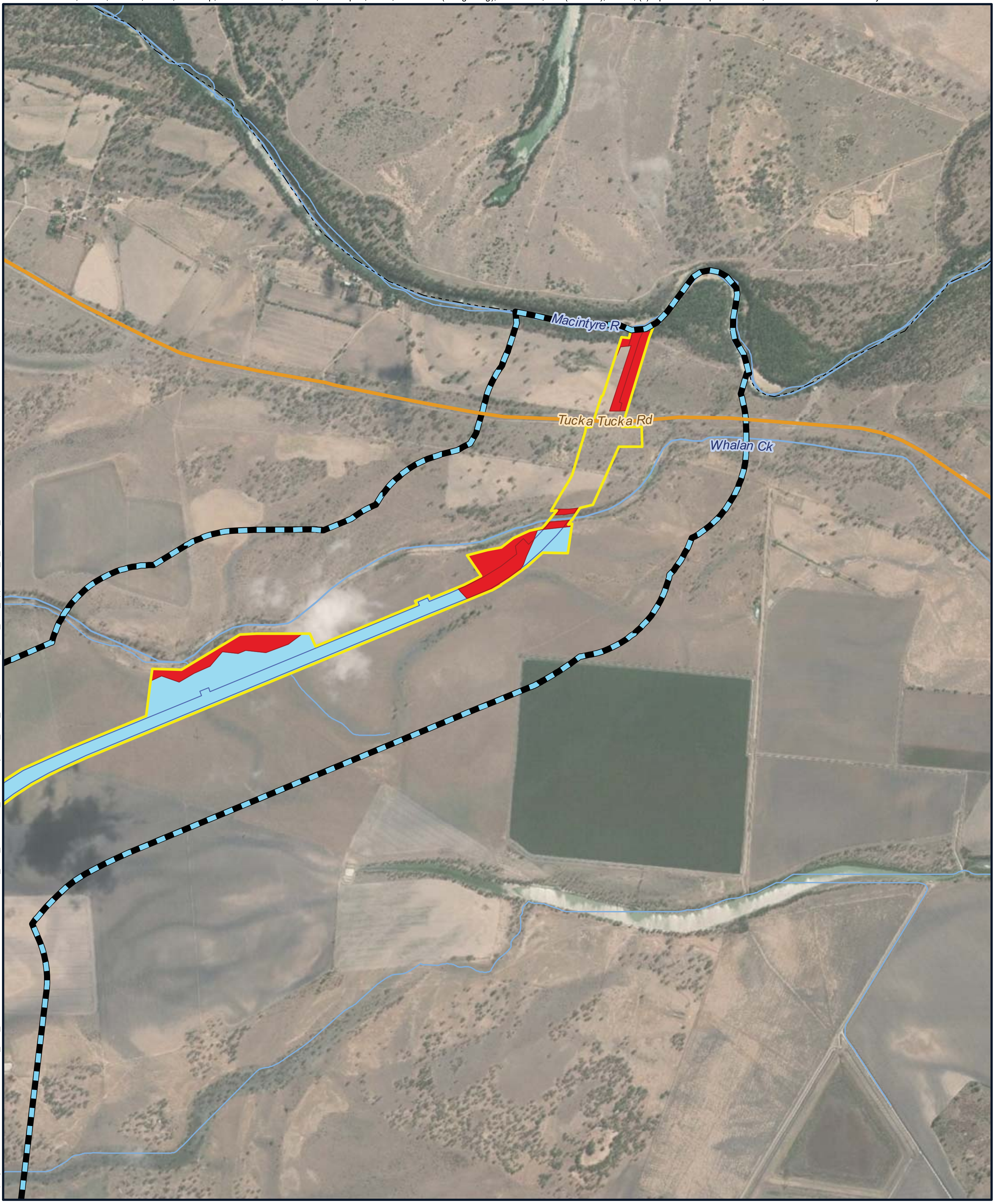
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Five-clawed worm-skink (*Anomalopus mackayi*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Five-clawed worm-skink (*Anomalopus mackayi*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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Legend

- Subject land
- Minor roads
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

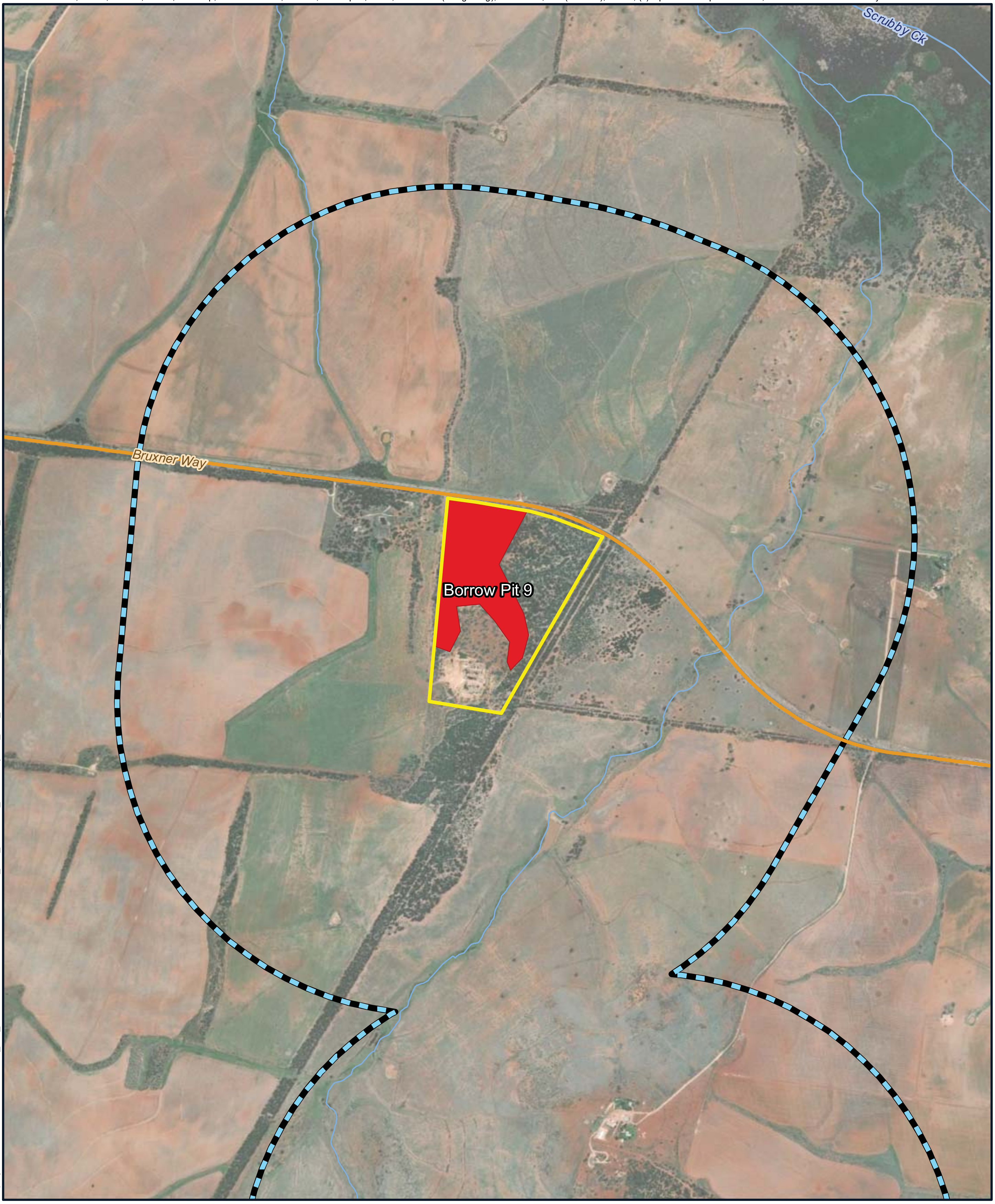
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Five-clawed worm-skink (*Anomalopus mackayi*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

Subject land
Major roads
Watercourses
Study area
Subject land
Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

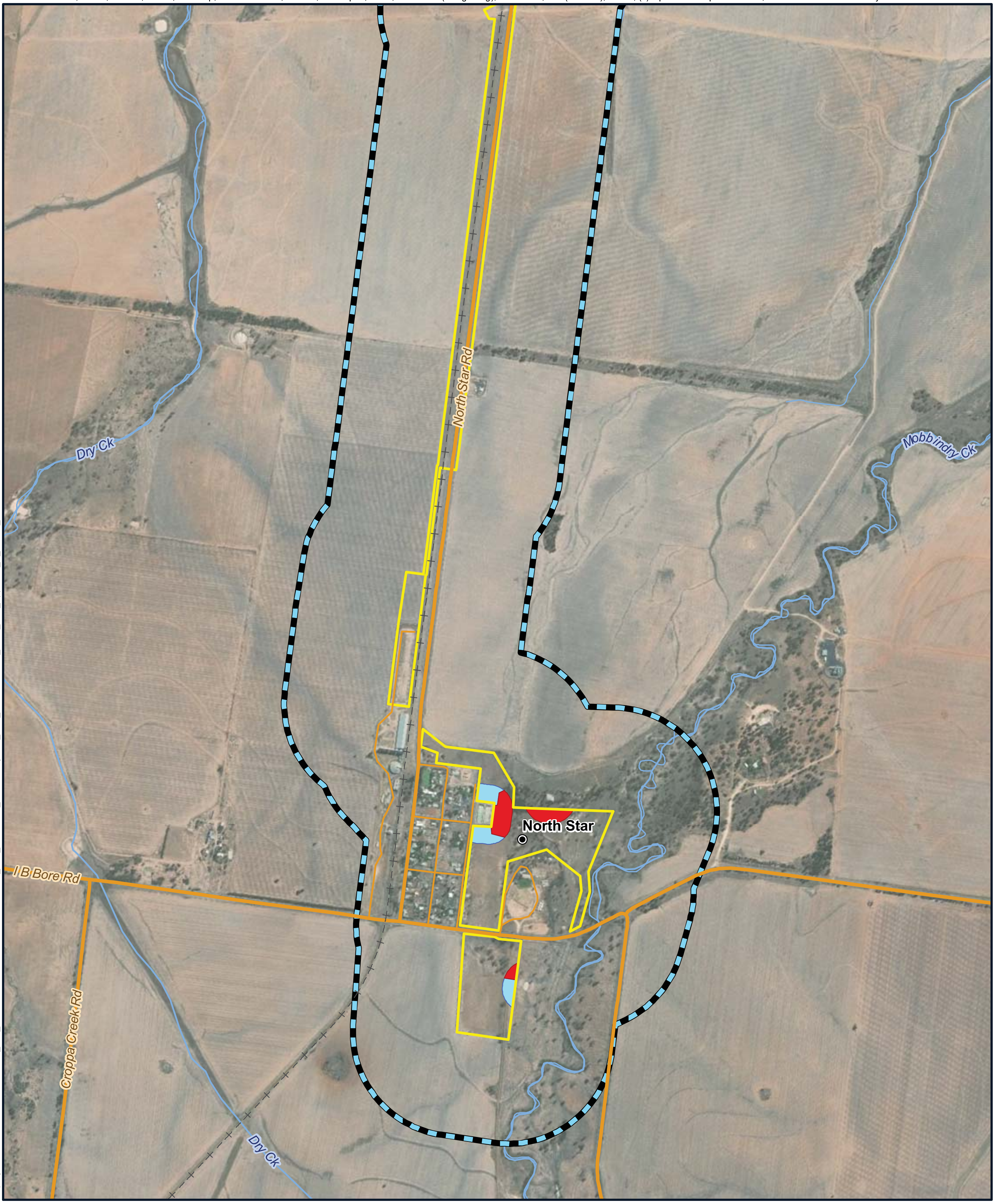
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Five-clawed worm-skink (*Anomalopus mackayi*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Localities
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

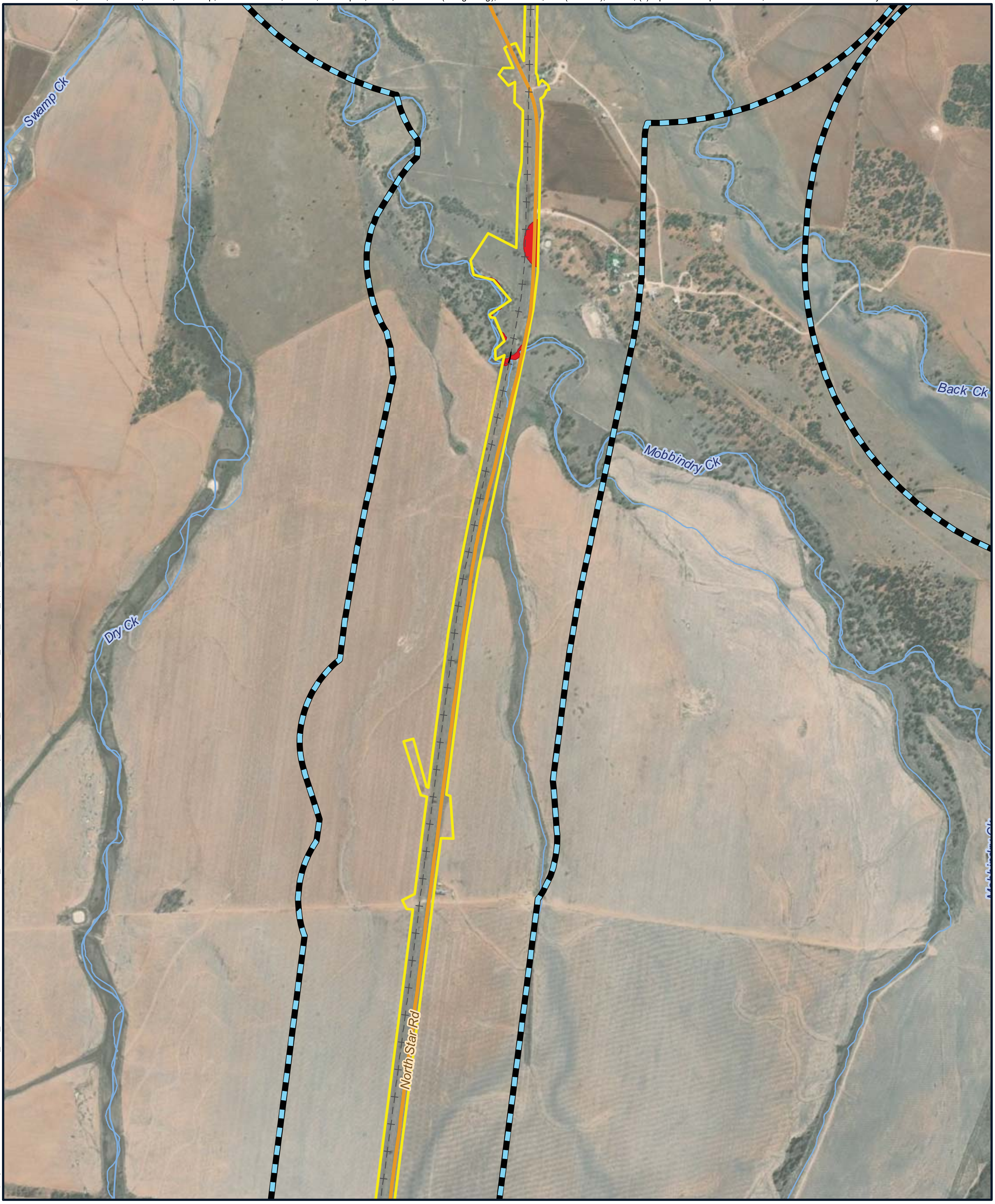
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Australasian bittern (*Botaurus poiciloptilus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

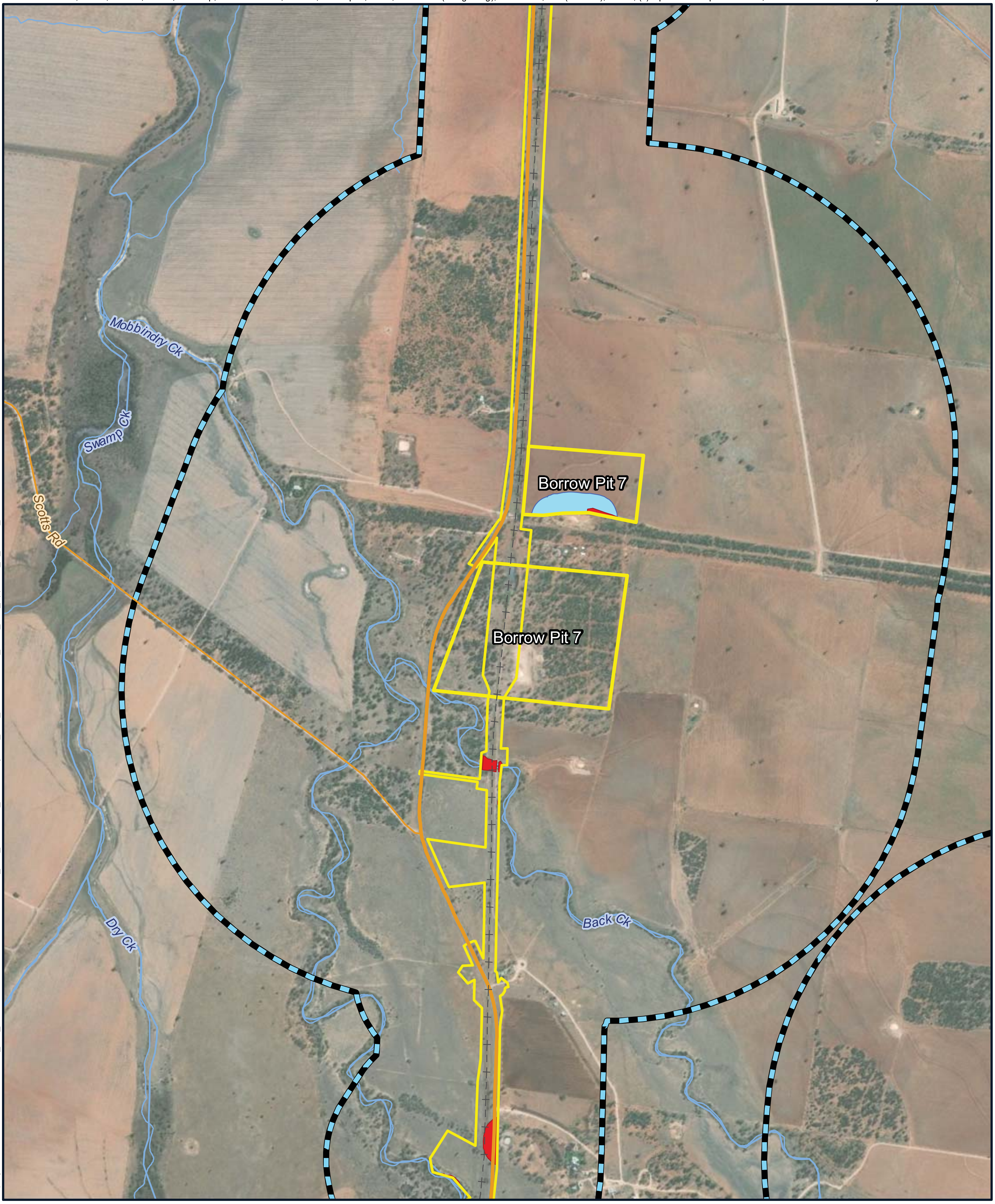
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Australasian bittern (*Botaurus poiciloptilus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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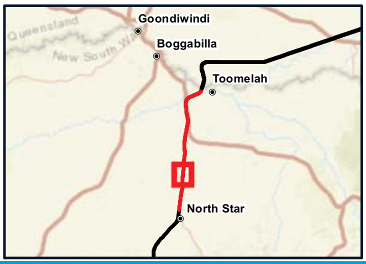
Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

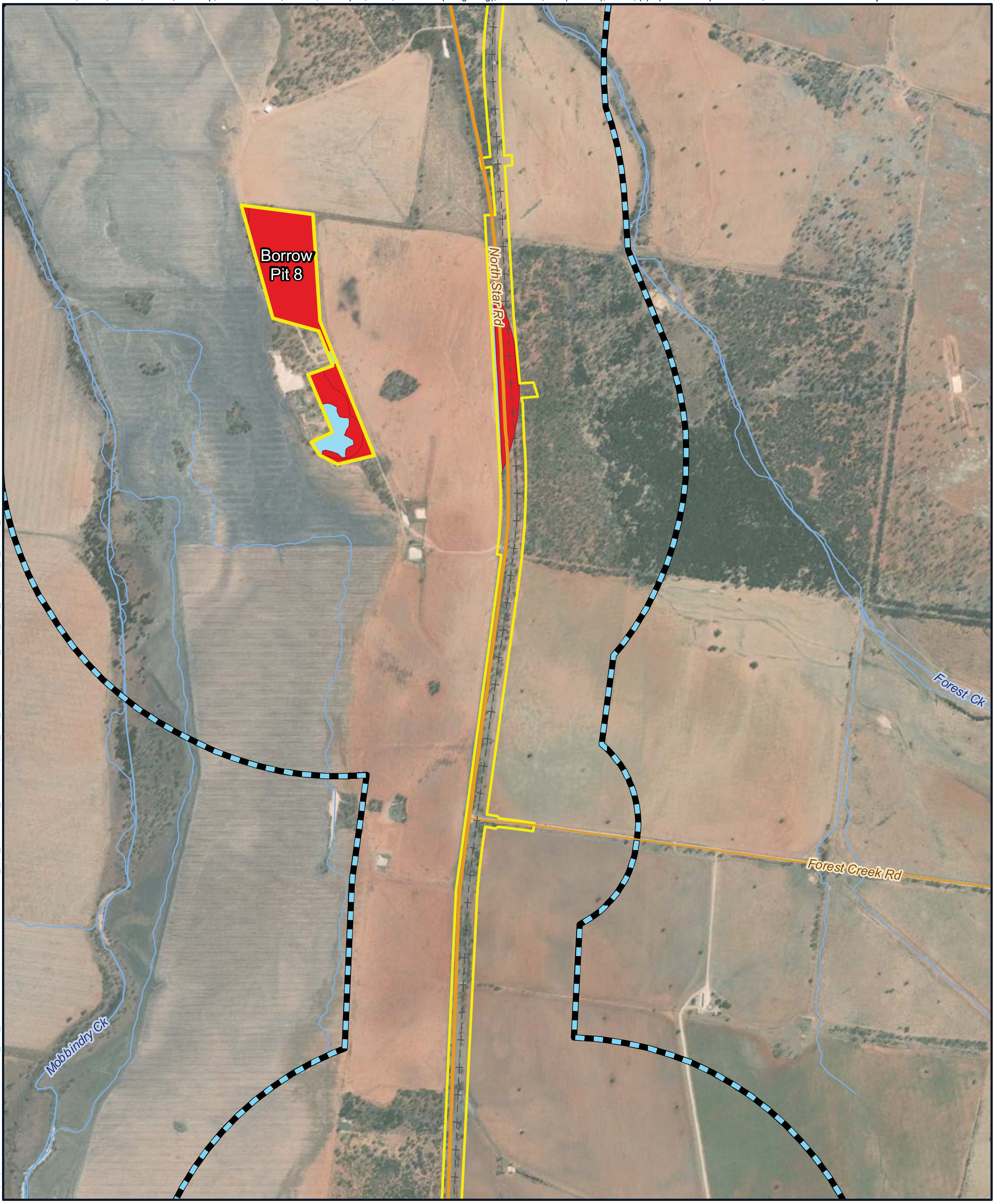
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Australasian bittern (*Botaurus poiciloptilus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

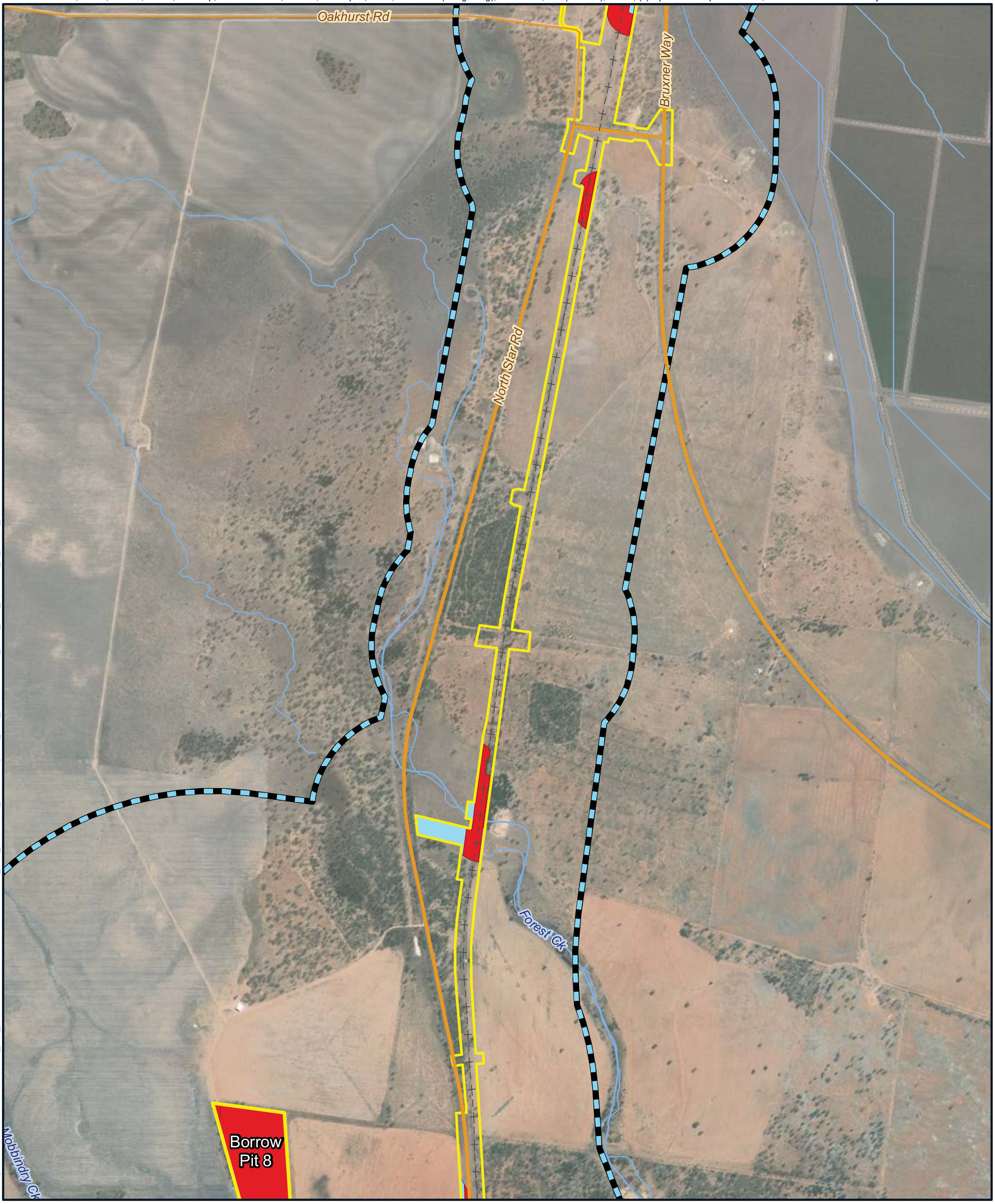
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Australasian bittern (*Botaurus poiciloptilus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

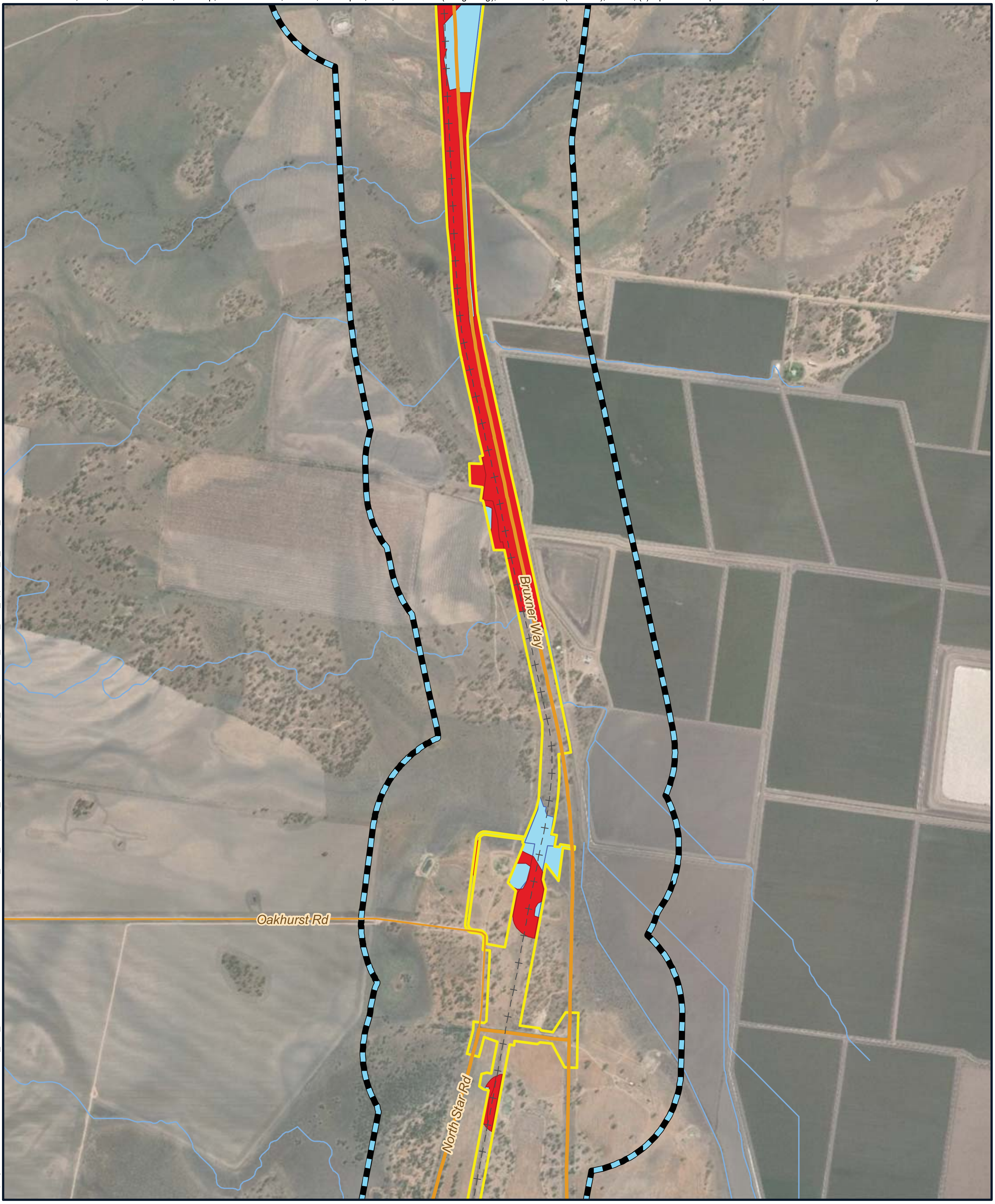
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Australasian bittern (*Botaurus poiciloptilus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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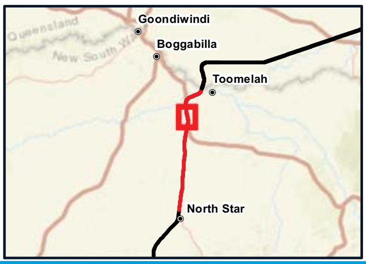
Legend

- Existing rail (non-operational)
- Major roads
- Minor roads
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

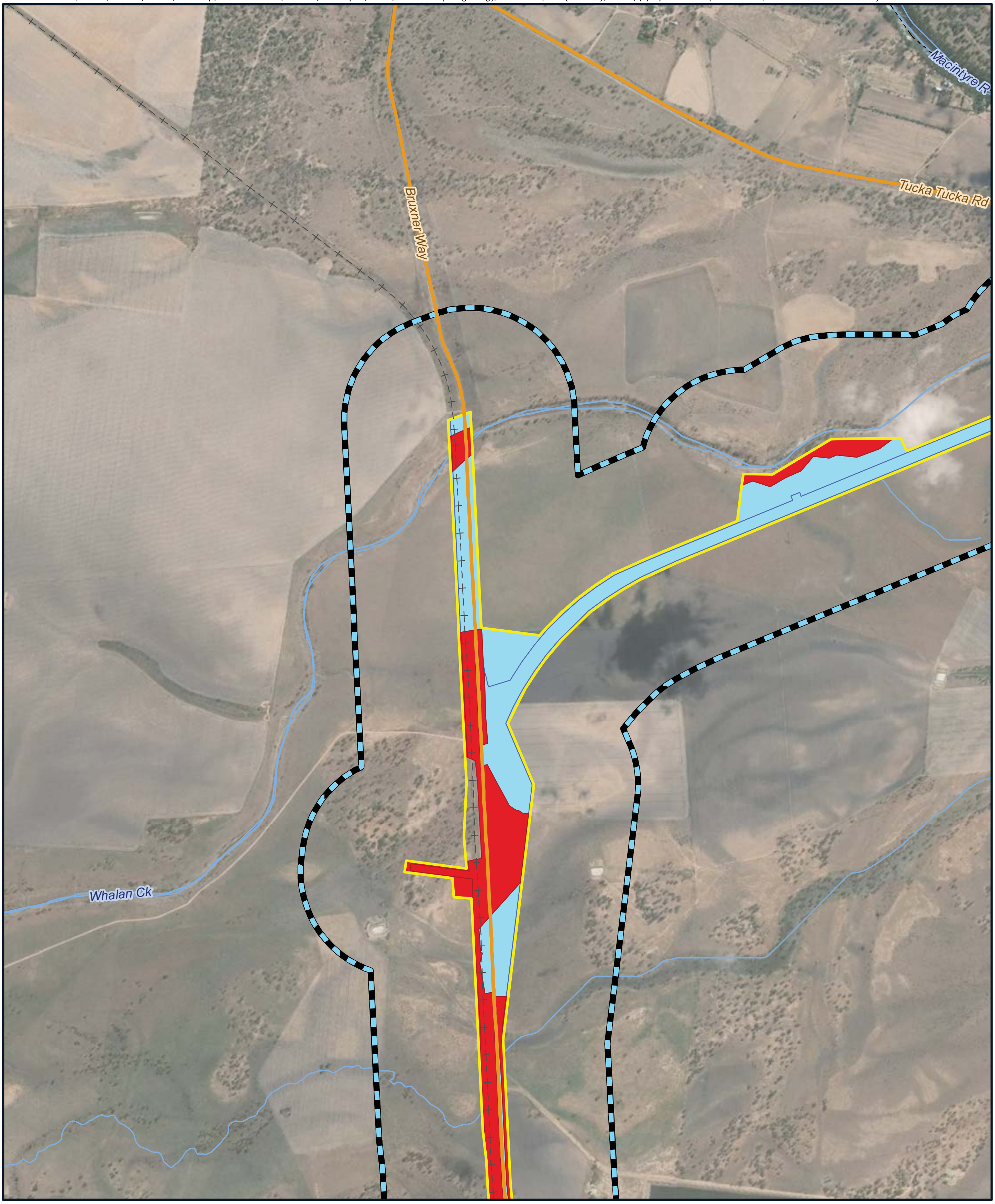
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Australasian bittern (*Botaurus poiciloptilus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Existing rail (non-operational)
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

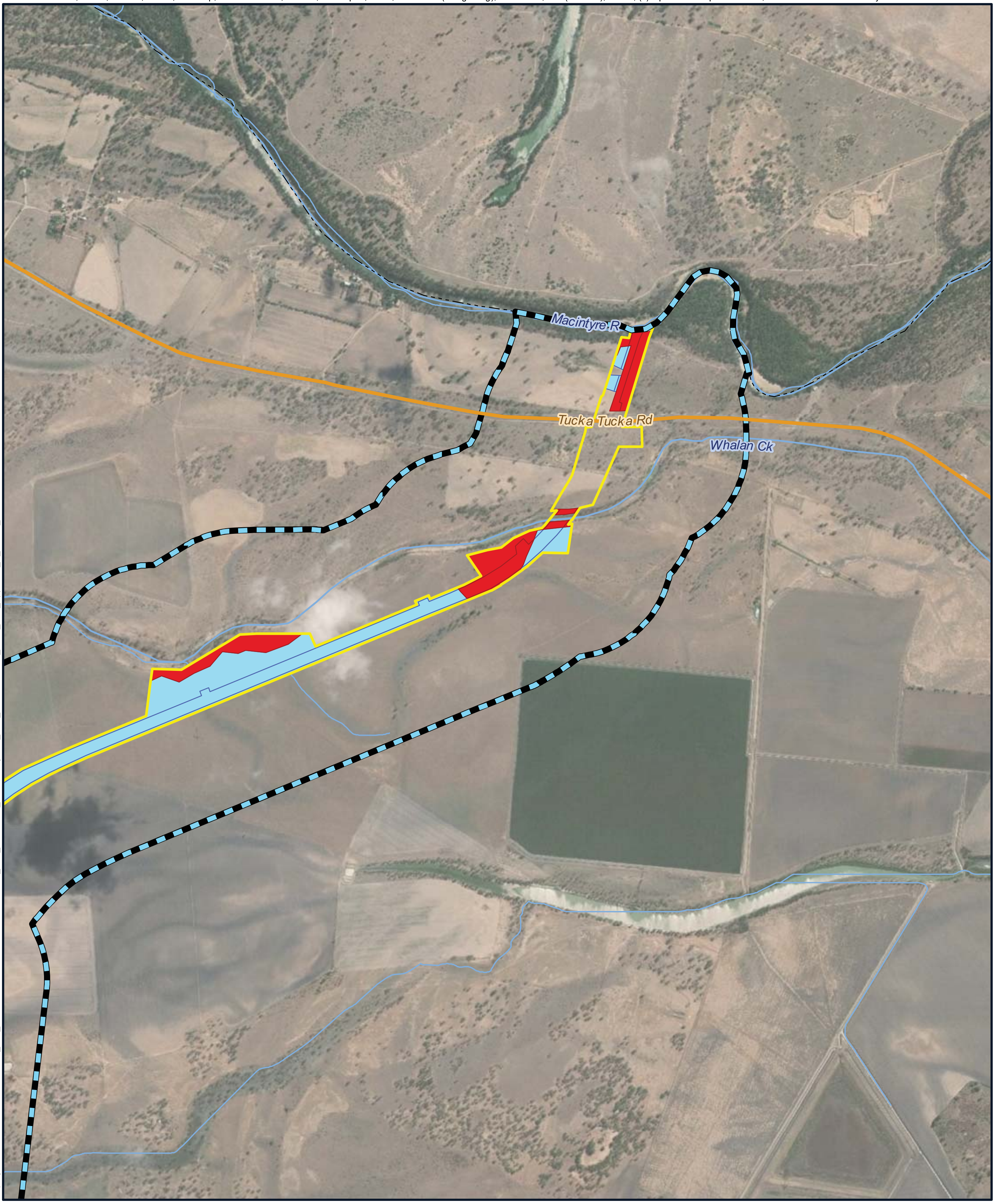
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Australasian bittern (*Botaurus poiciloptilus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

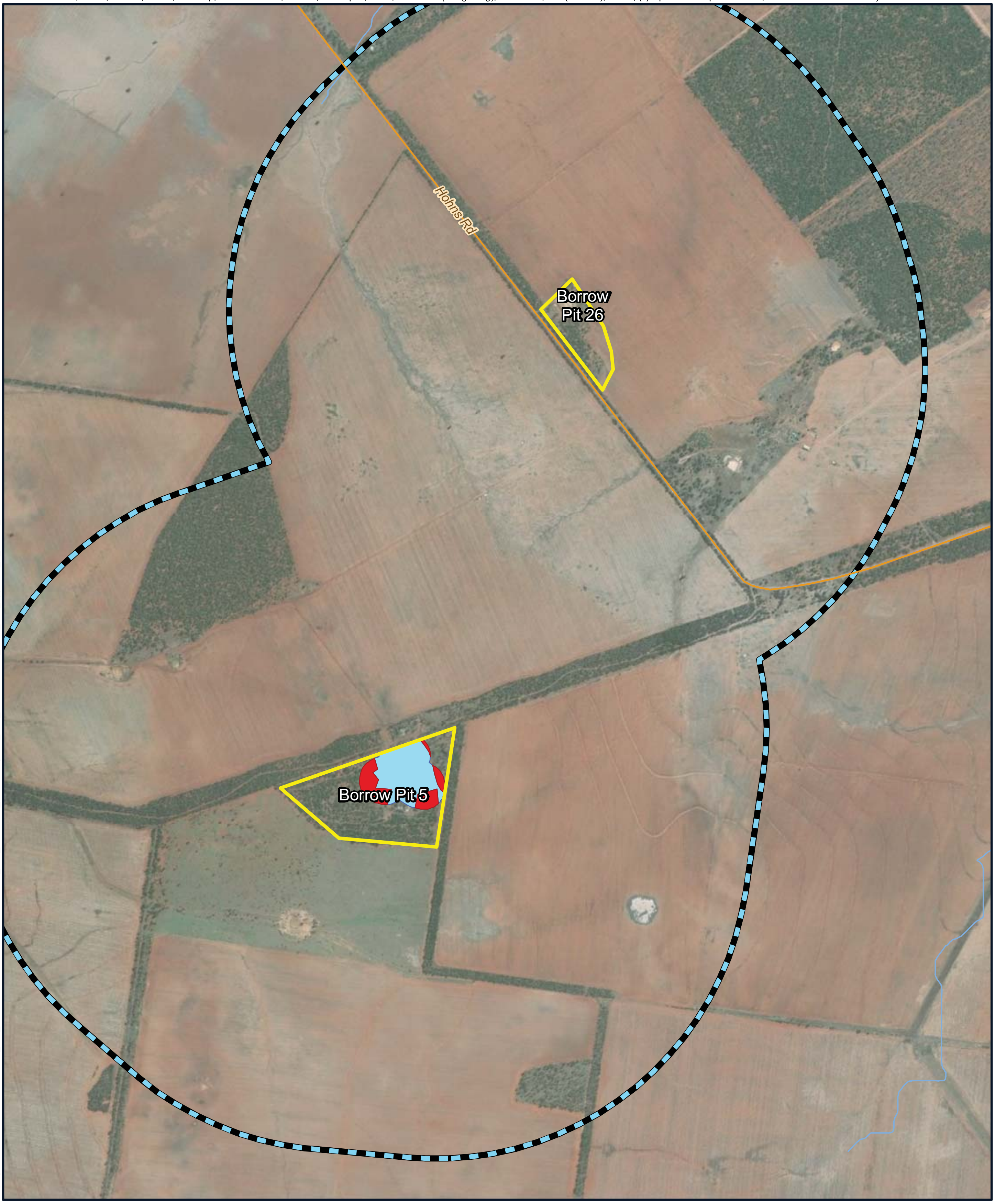
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Australasian bittern (*Botaurus poiciloptilus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Subject land
- Minor roads
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Australasian bittern (*Botaurus poiciloptilus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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Legend

Subject land
Minor roads
Watercourses
Study area
Subject land
Adversely impacted habitat
Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

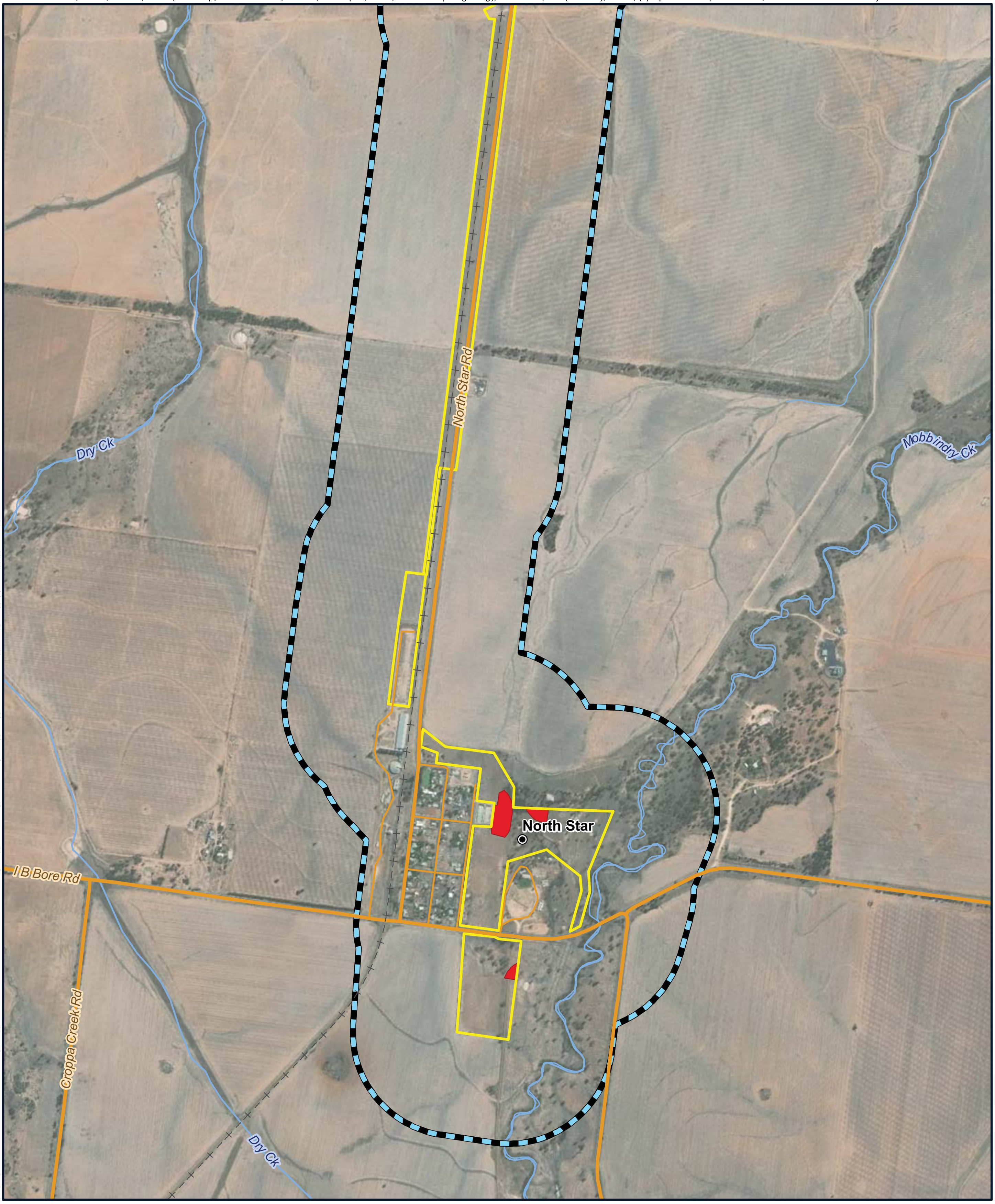
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Australasian bittern (*Botaurus poiciloptilus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Localities
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

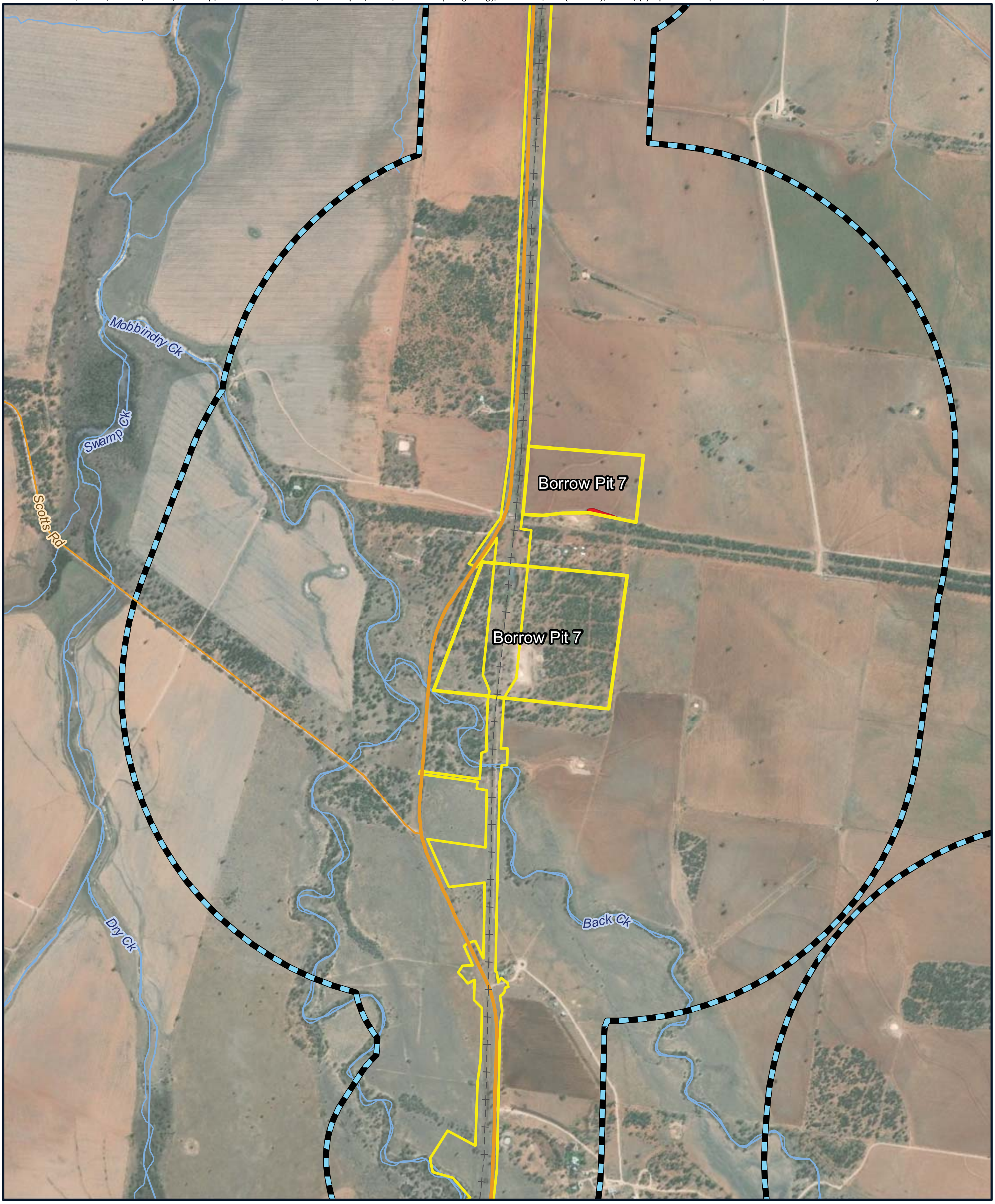
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Curlew sandpiper (*Calidris ferruginea*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

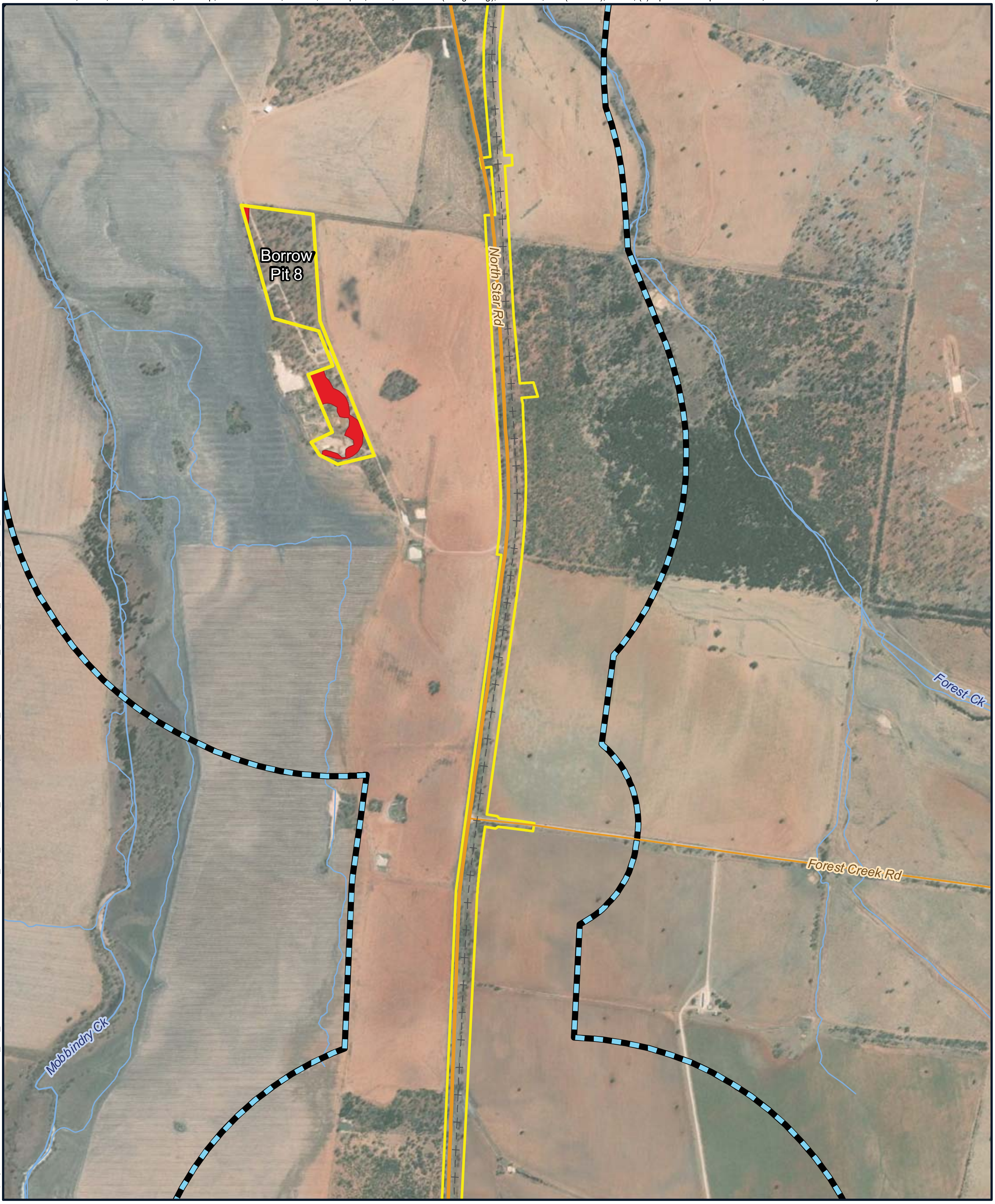
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Curlew sandpiper (*Calidris ferruginea*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

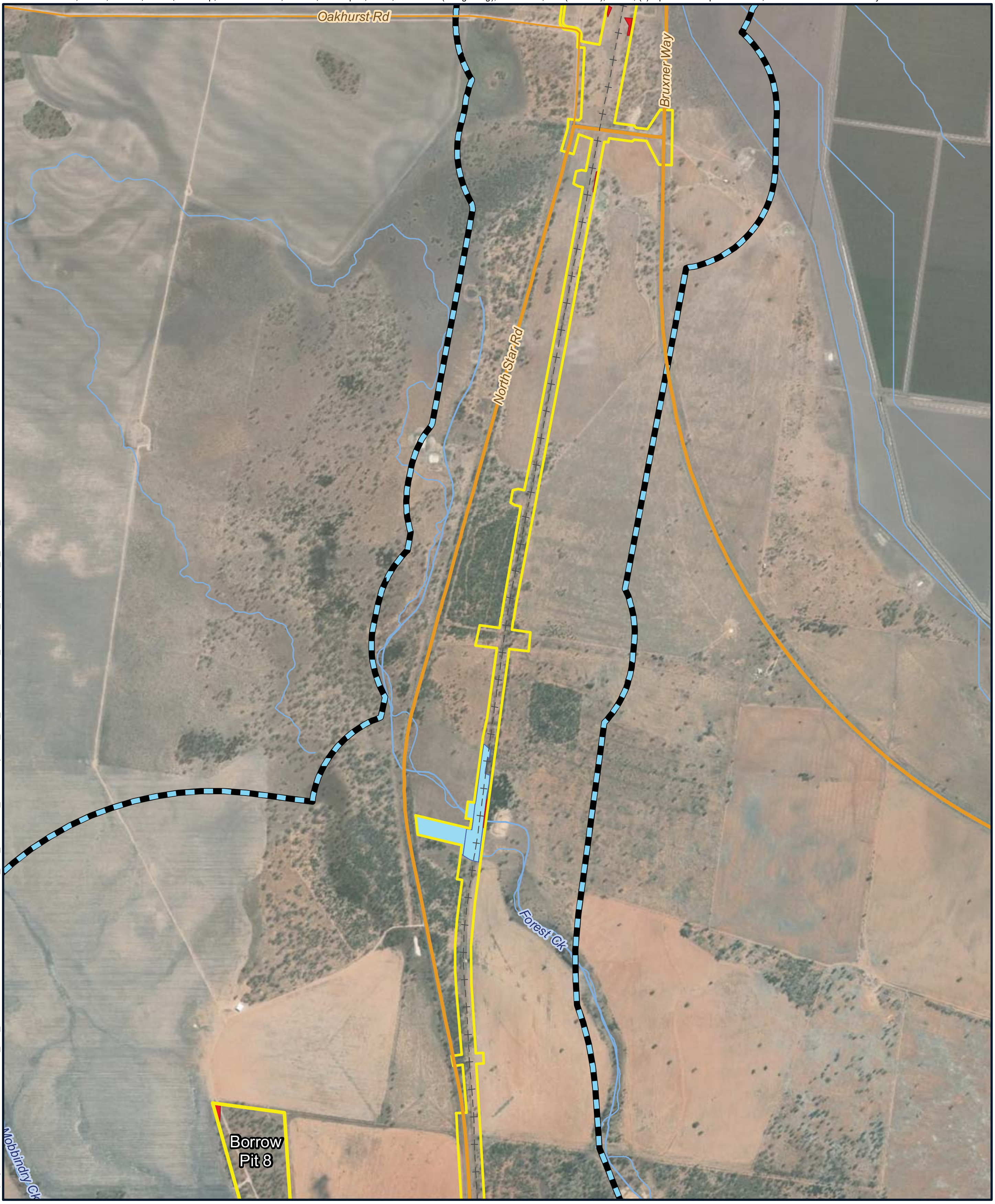
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Curlew sandpiper (*Calidris ferruginea*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

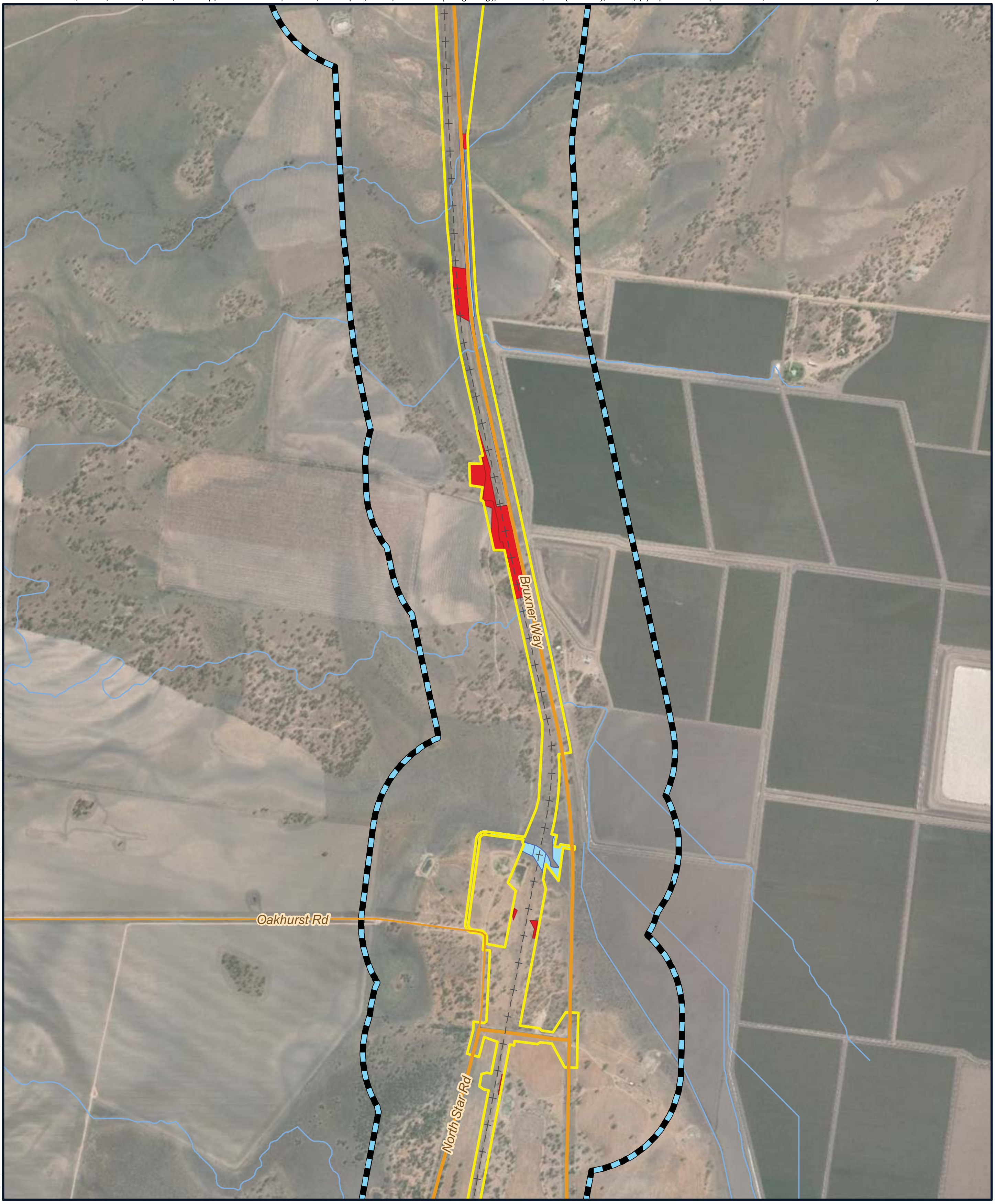
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Curlew sandpiper (*Calidris ferruginea*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Existing rail (non-operational)
- Major roads
- Minor roads
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

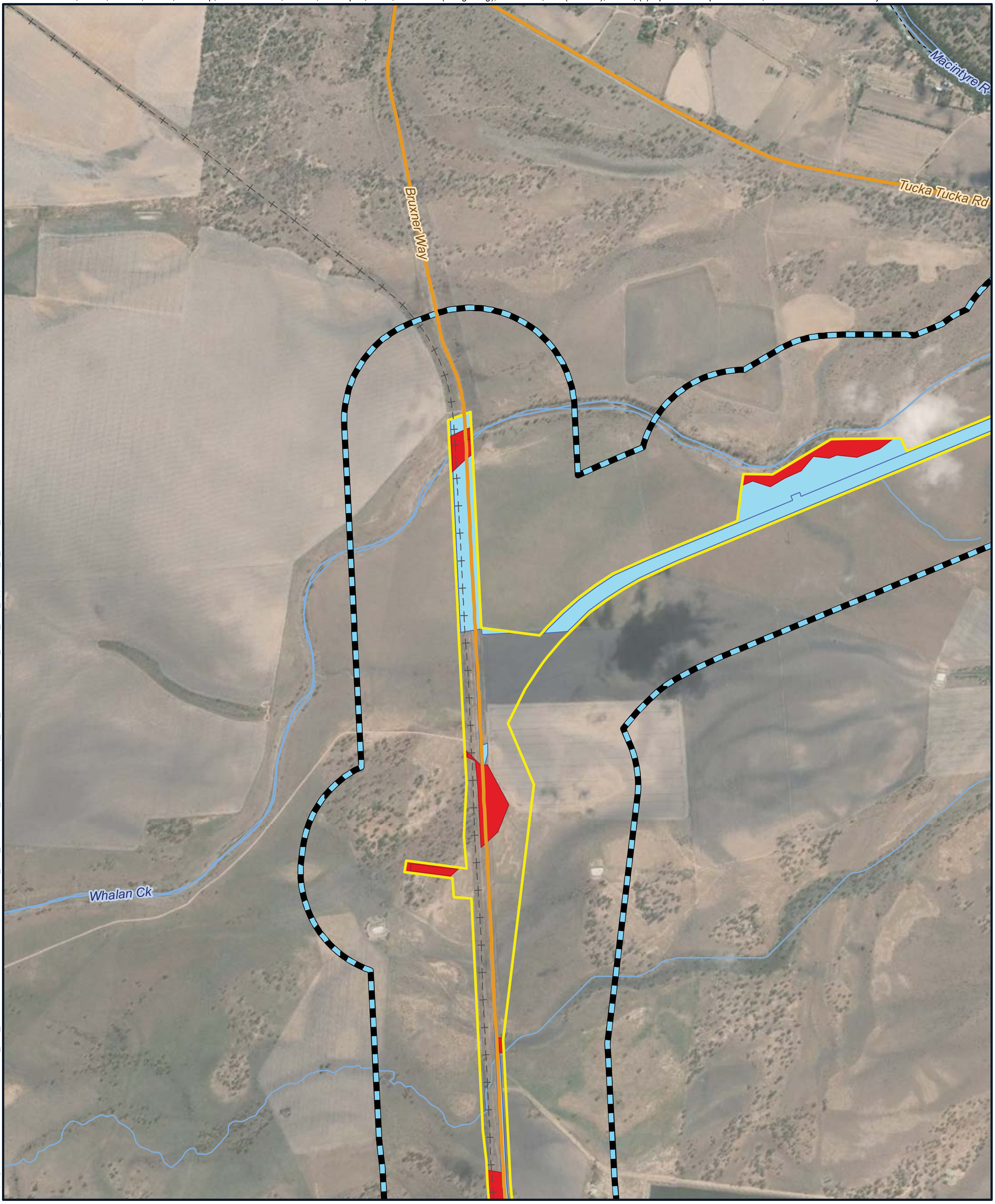
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Curlew sandpiper (*Calidris ferruginea*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Existing rail (non-operational)
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

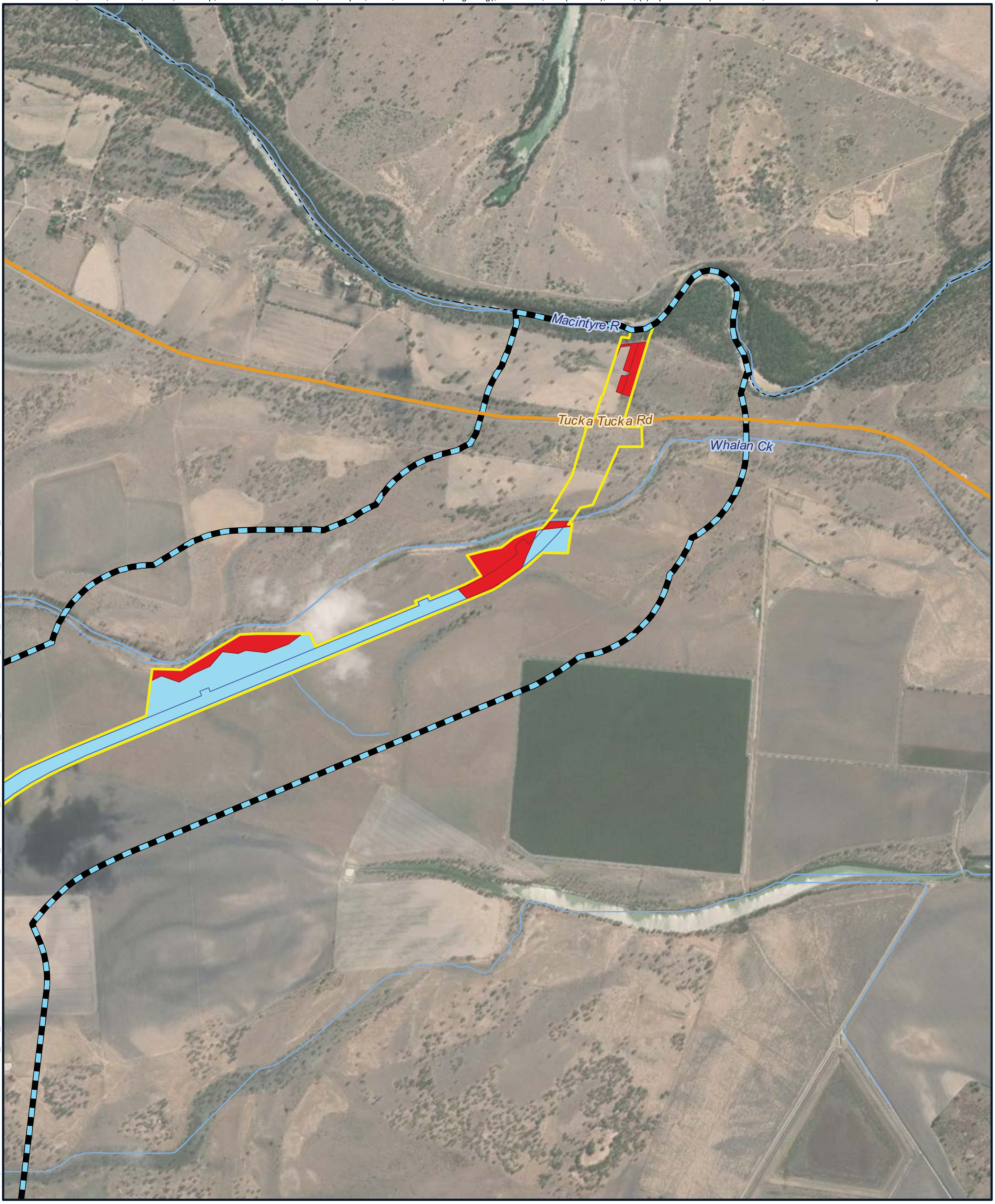
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Curlew sandpiper (*Calidris ferruginea*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

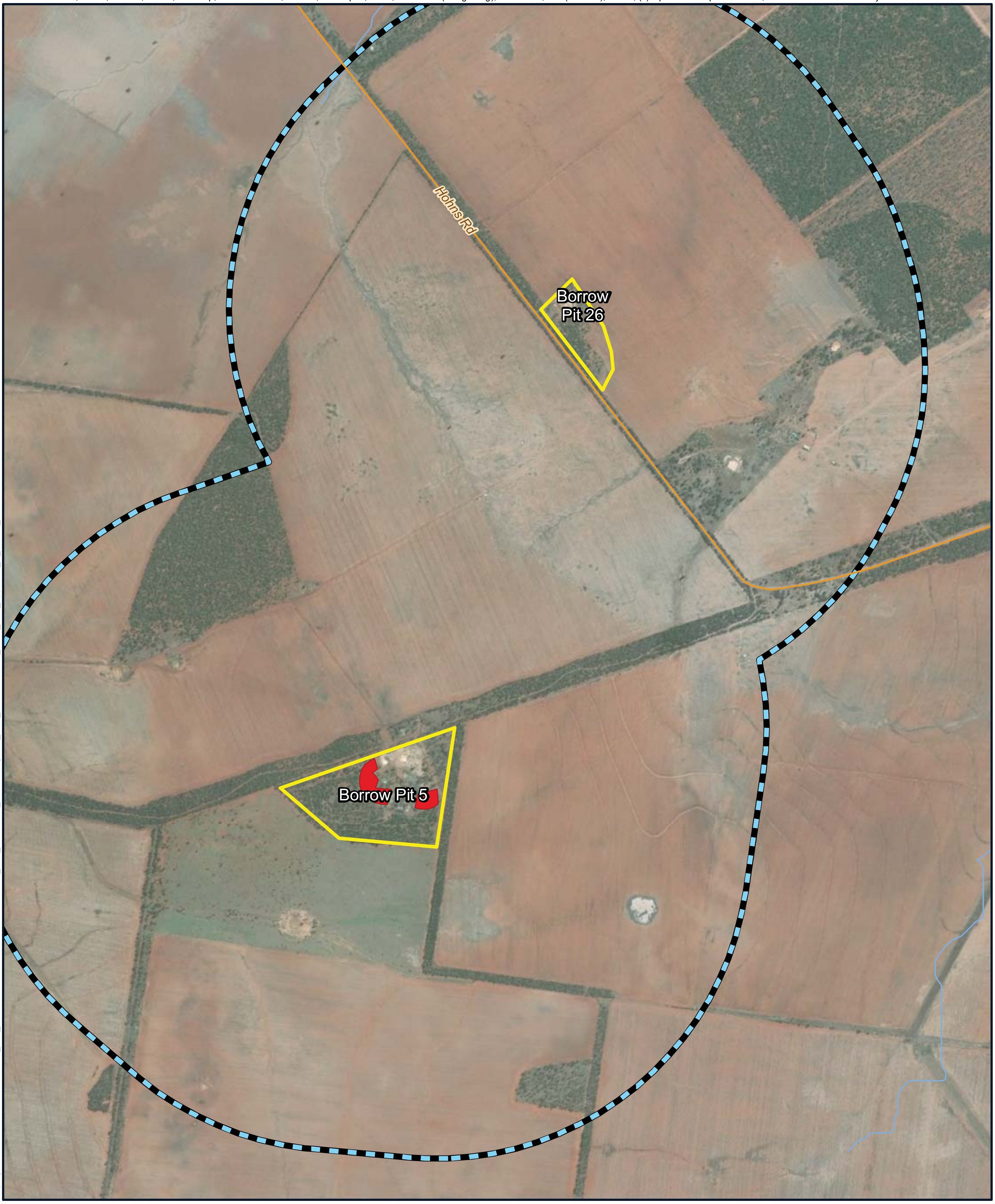
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Curlew sandpiper (*Calidris ferruginea*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Subject land
- Minor roads
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Curlew sandpiper (*Calidris ferruginea*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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Legend

Subject land
Minor roads
Watercourses
Study area
Subject land
Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

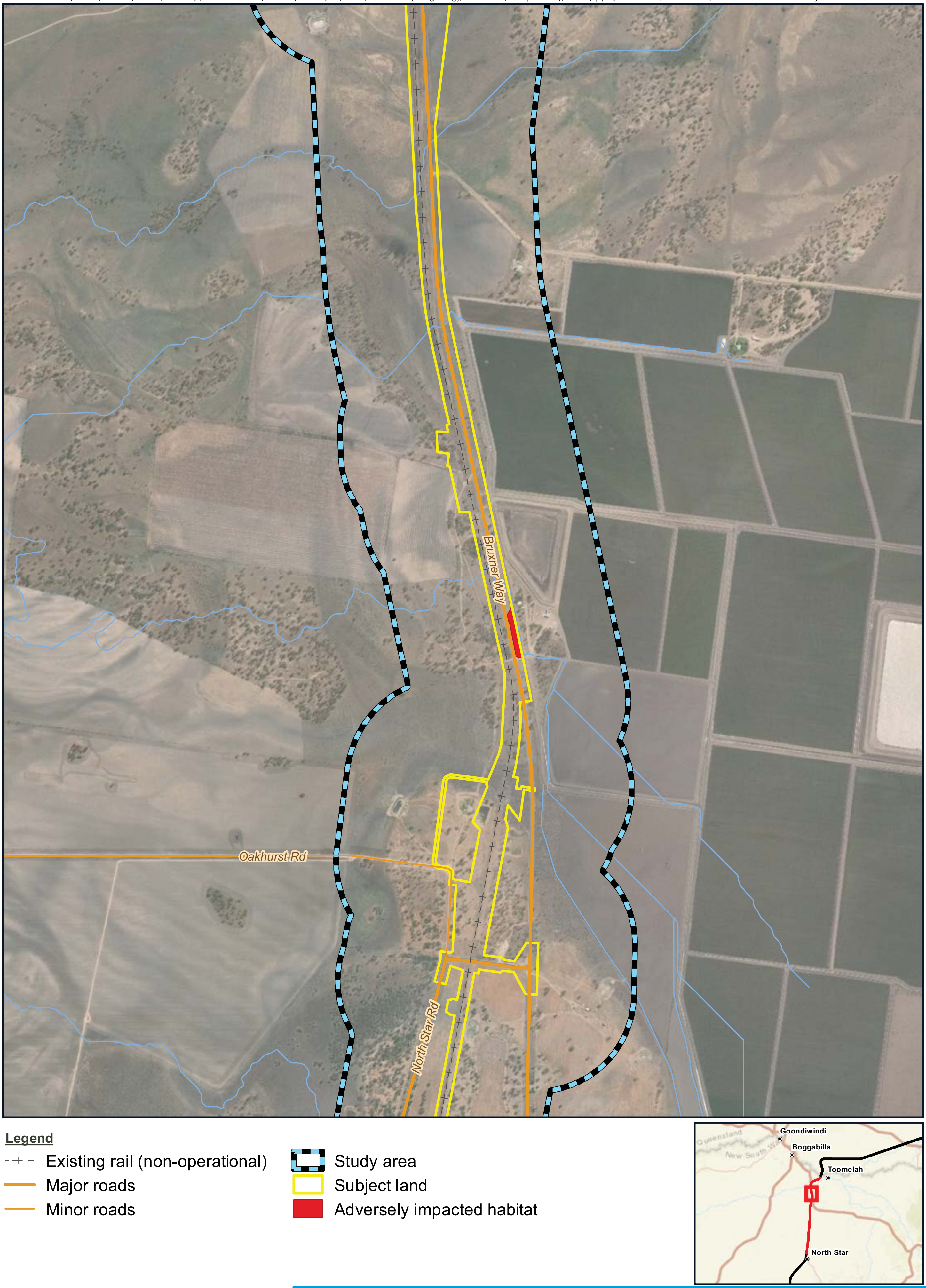
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Curlew sandpiper (*Calidris ferruginea*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Existing rail (non-operational)
- Major roads
- Minor roads
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

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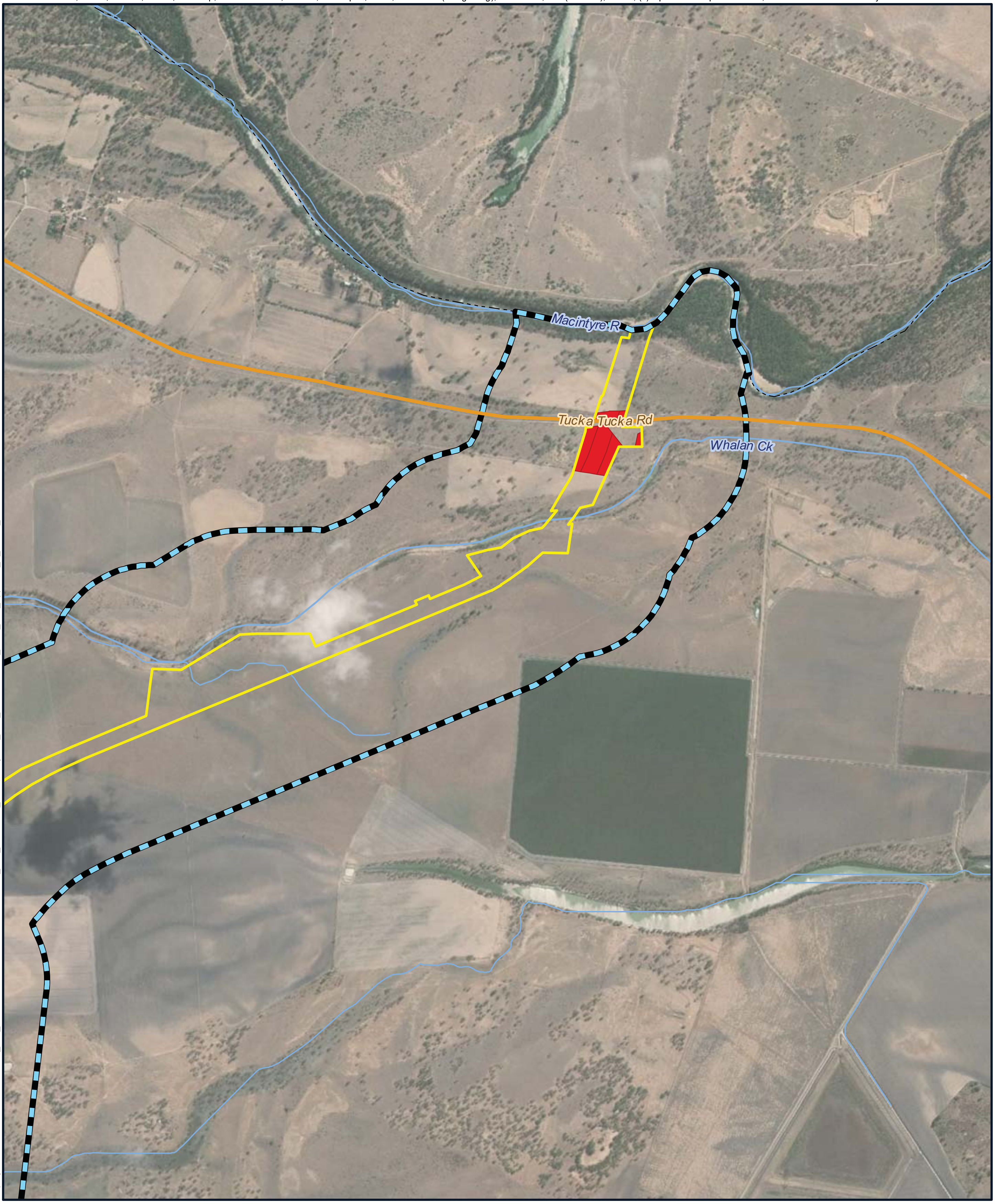
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Large-eared pied bat (*Chalinolobus dwyeri*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

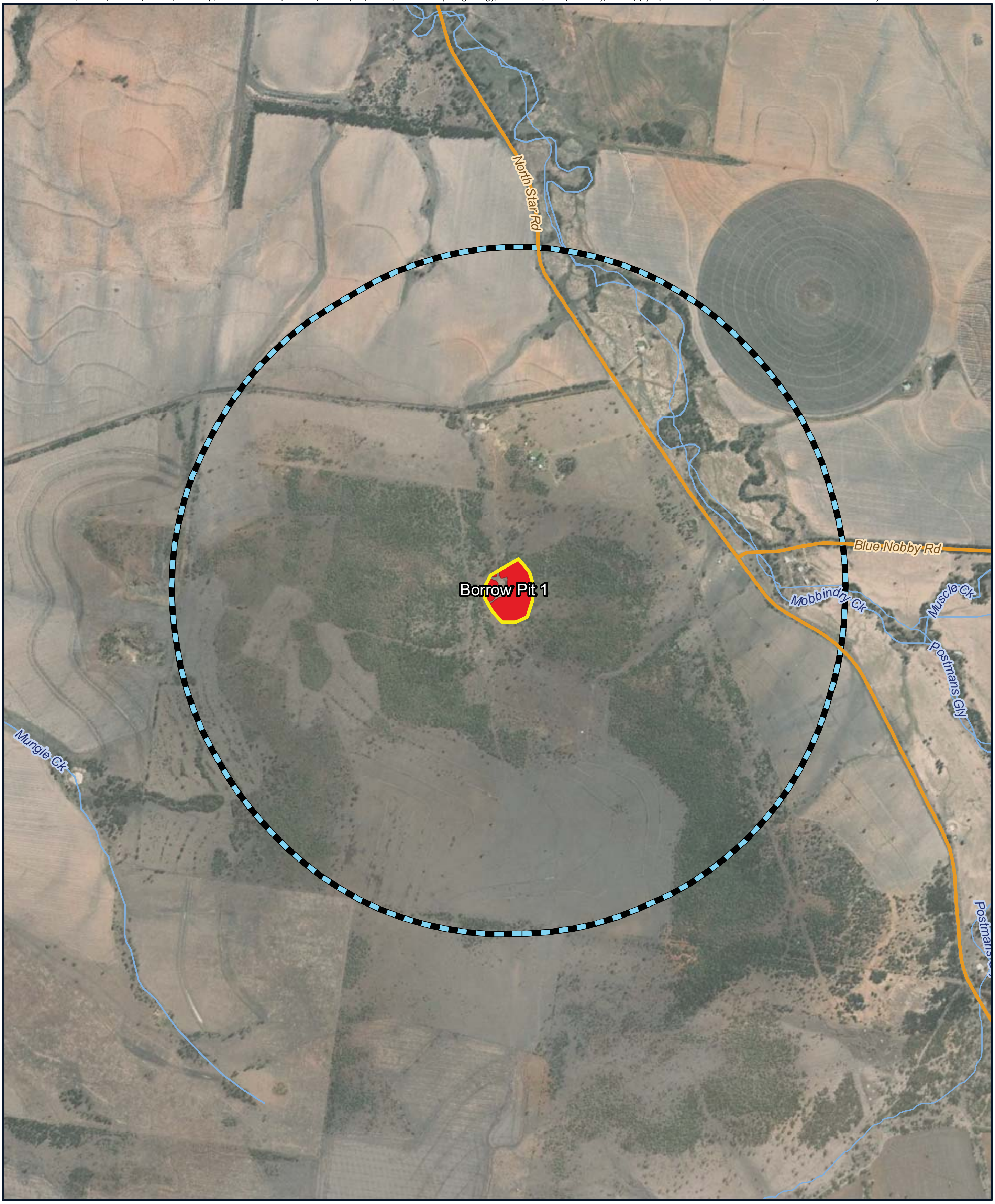
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Large-eared pied bat (*Chalinolobus dwyeri*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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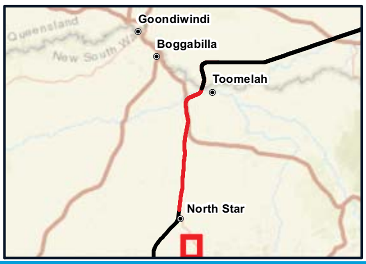
Legend

- Subject land
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Large-eared pied bat (*Chalinolobus dwyeri*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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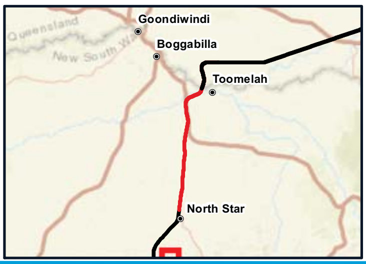
Legend

Subject land
Major roads
Watercourses
Study area
Subject land
Adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

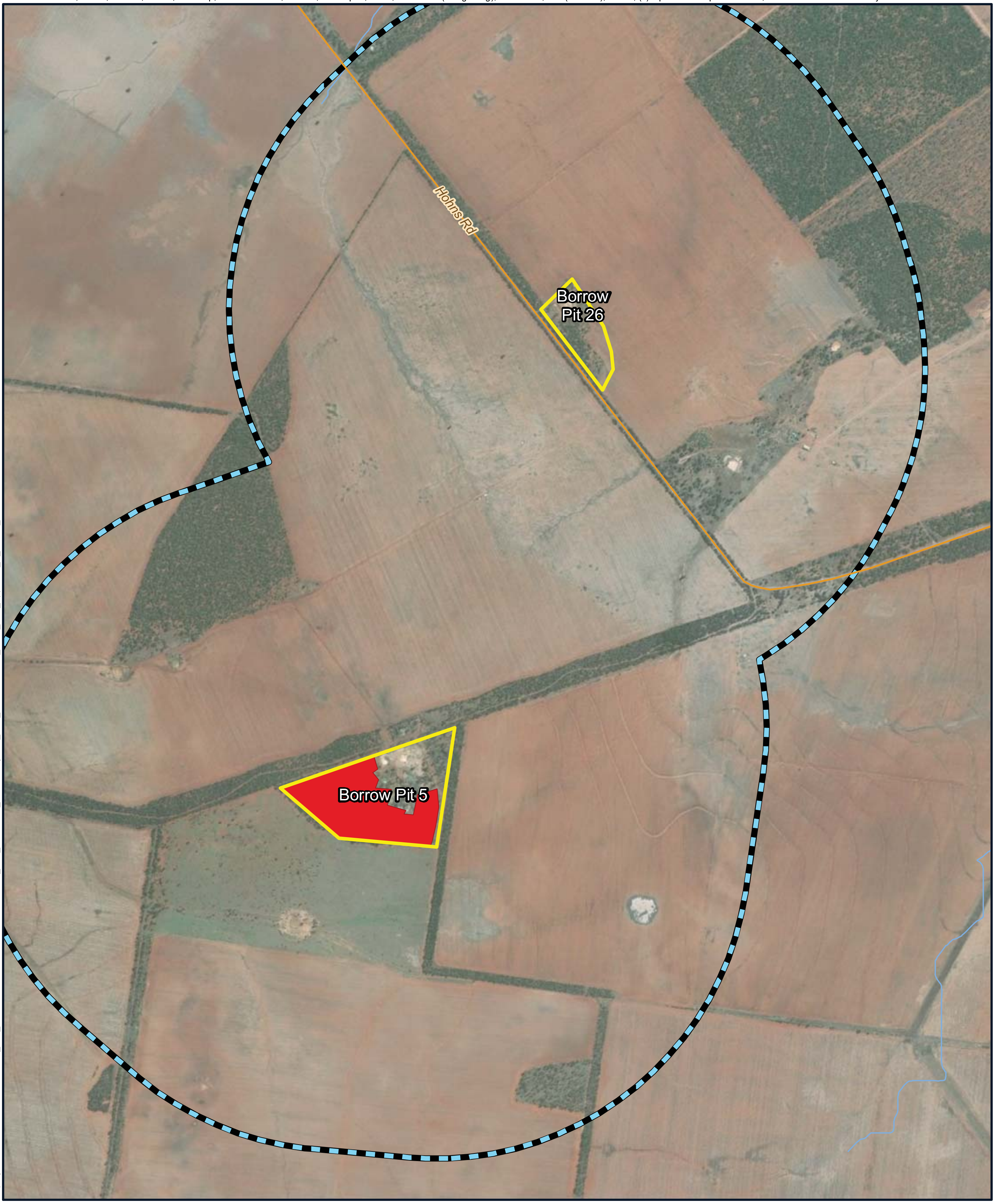
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Large-eared pied bat (*Chalinolobus dwyeri*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

Subject land
Minor roads
Study area
Subject land
Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

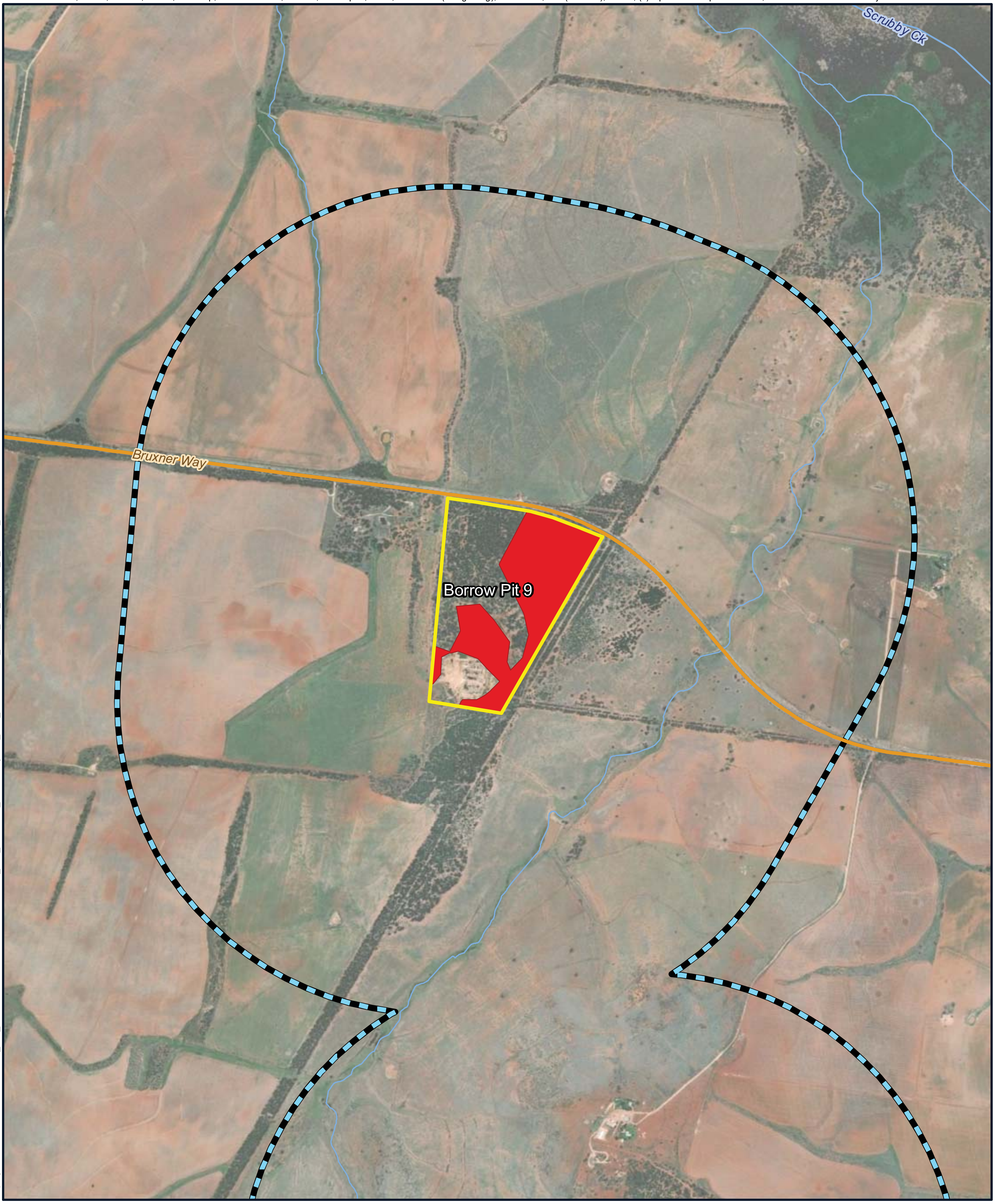
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Large-eared pied bat (*Chalinolobus dwyeri*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Subject land
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Large-eared pied bat (*Chalinolobus dwyeri*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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Legend

- Subject land
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

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Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Large-eared pied bat (*Chalinolobus dwyeri*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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Legend

Major roads
Watercourses
Study area
Subject land
Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

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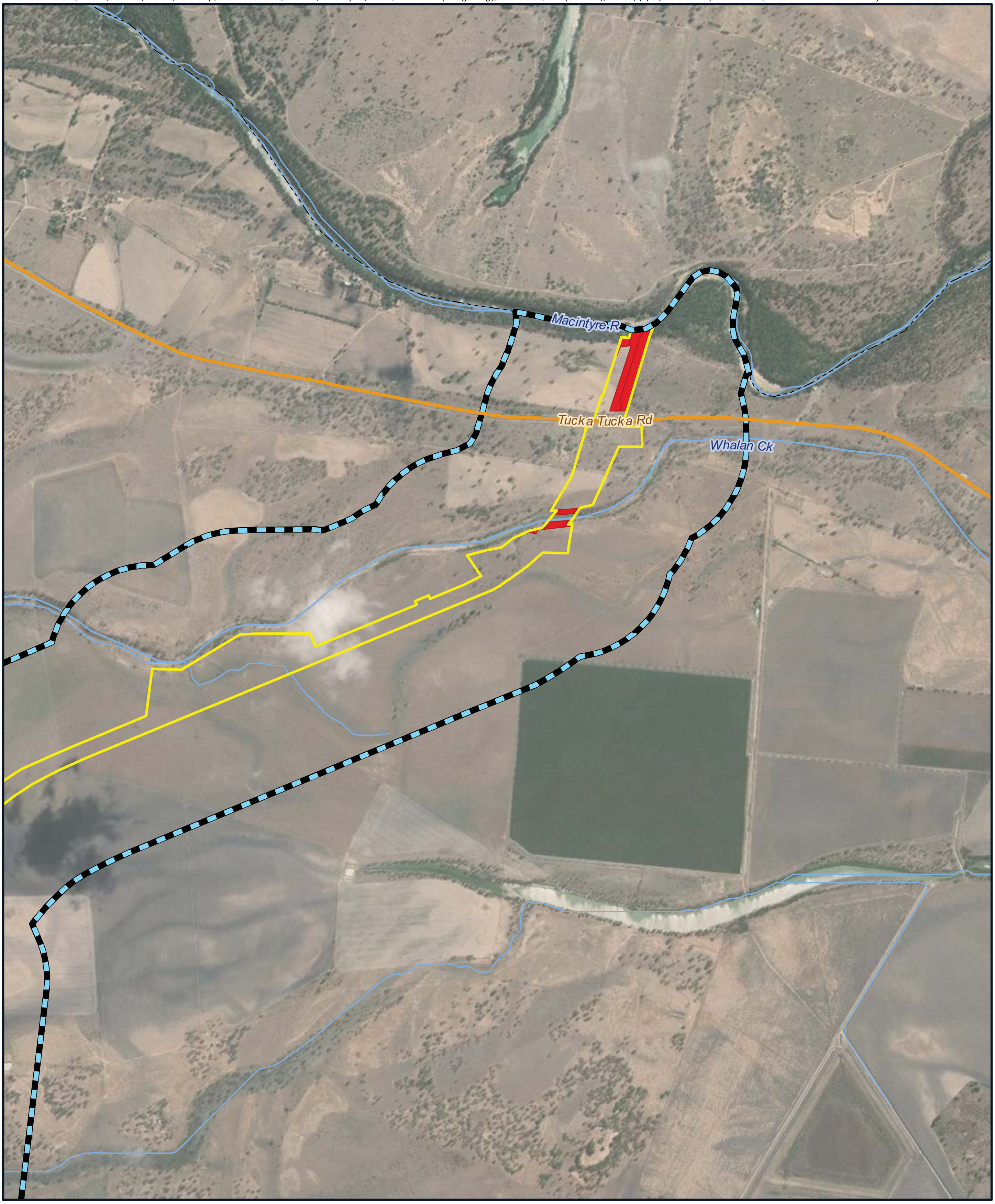
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Spot-tailed quoll (*Dasyurus maculatus maculatus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

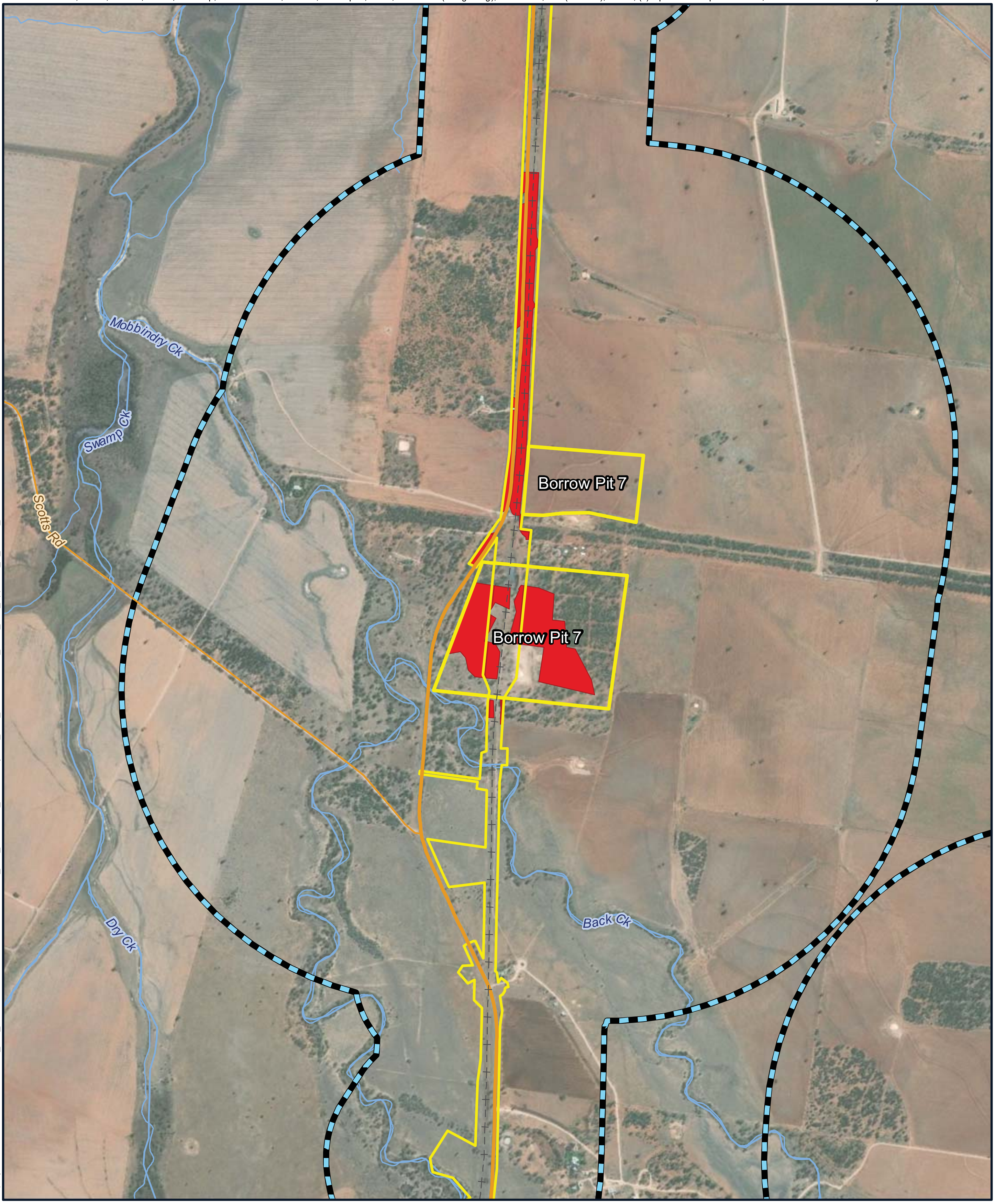
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Red goshawk (*Erythrotriorchis radiatus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

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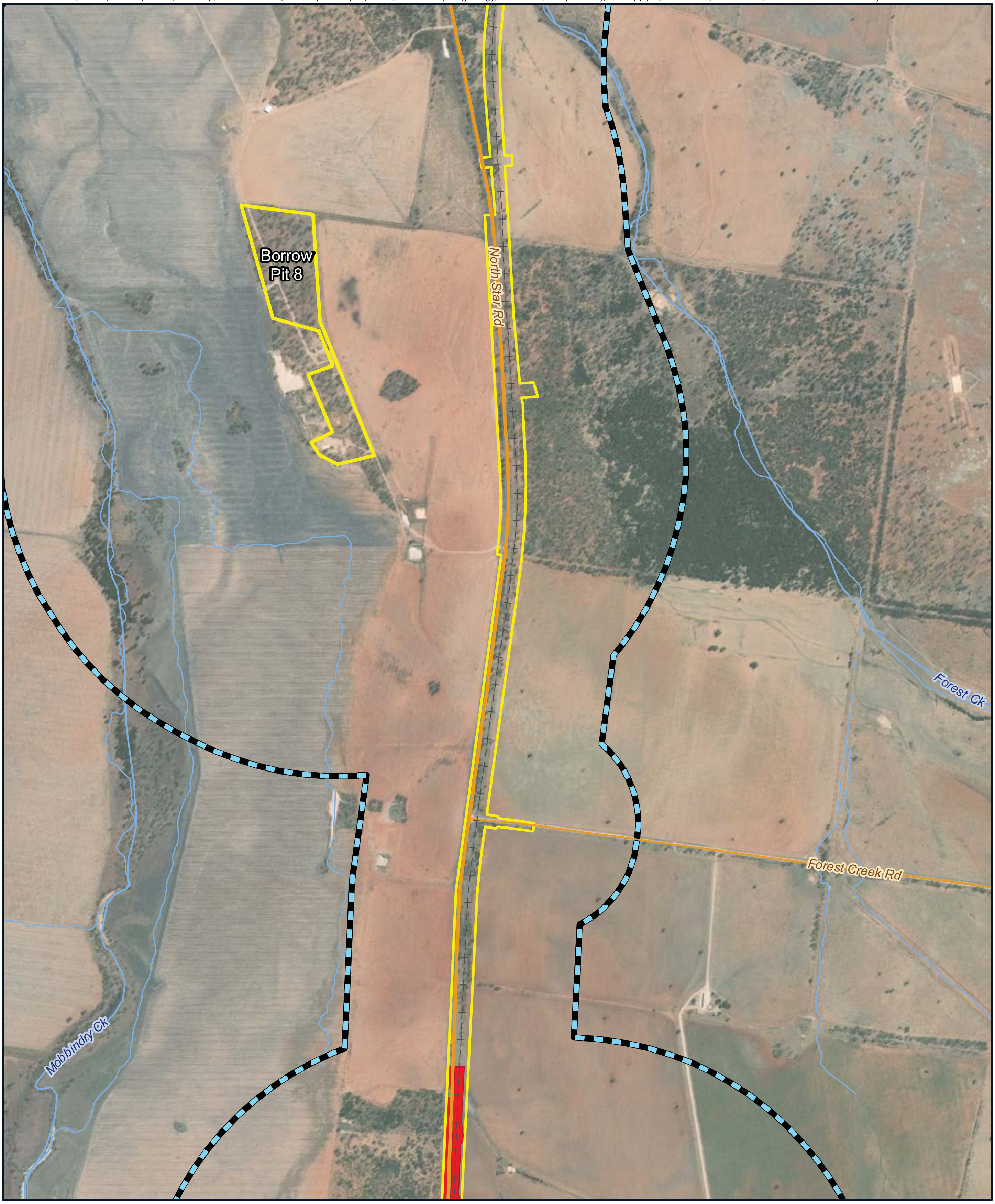
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Dunmall's snake (*Furina dunmalli*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

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Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Dunmall's snake (*Furina dunmalli*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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Legend

Subject land
Minor roads
Study area
Subject land
Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

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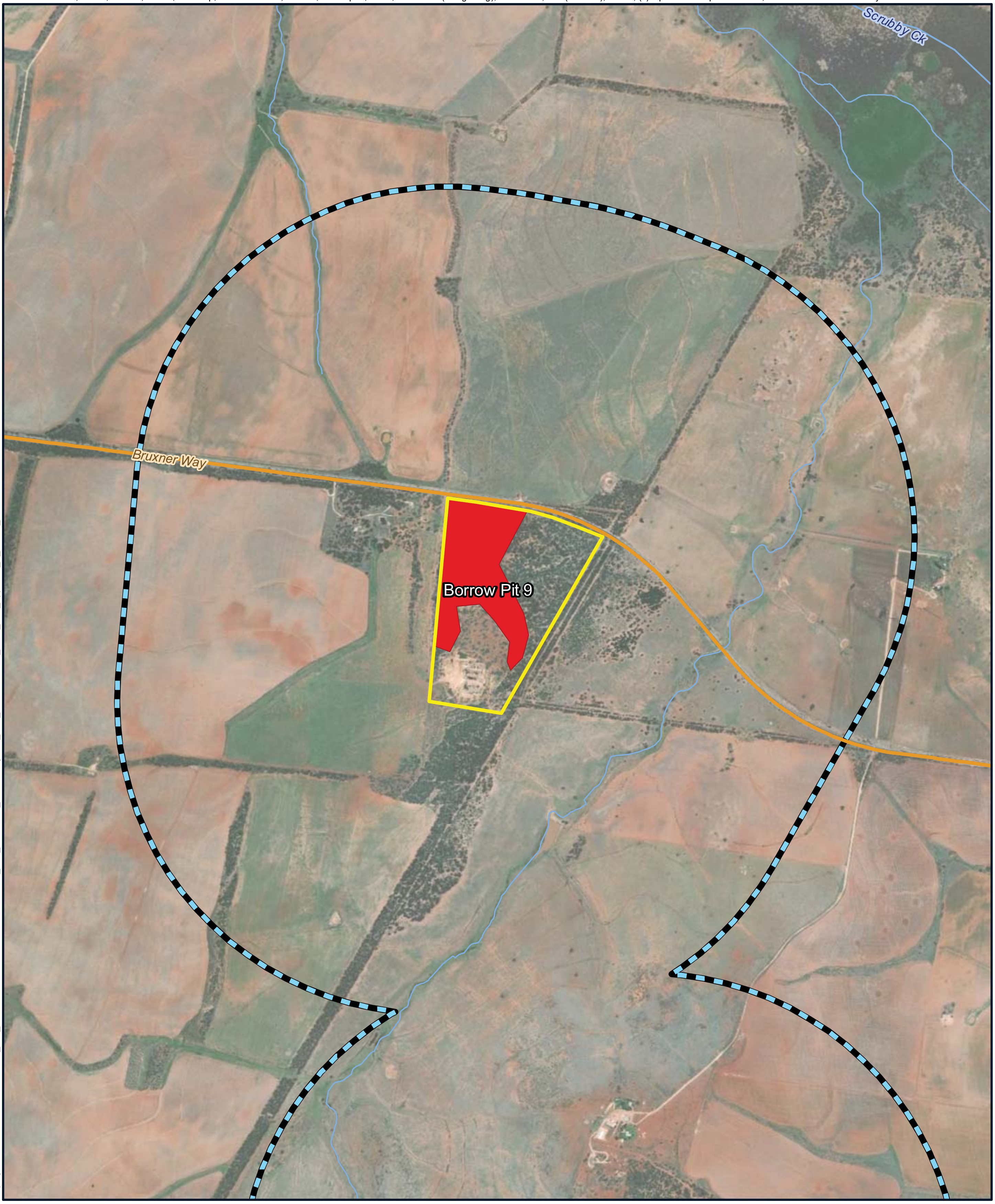
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Dunmall's snake (*Furina dunmalli*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

Subject land
Major roads
Watercourses
Study area
Subject land
Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

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Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Dunmall's snake (*Furina dunmalli*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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Legend

- Subject land
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
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Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Dunmall's snake (*Furina dunmalli*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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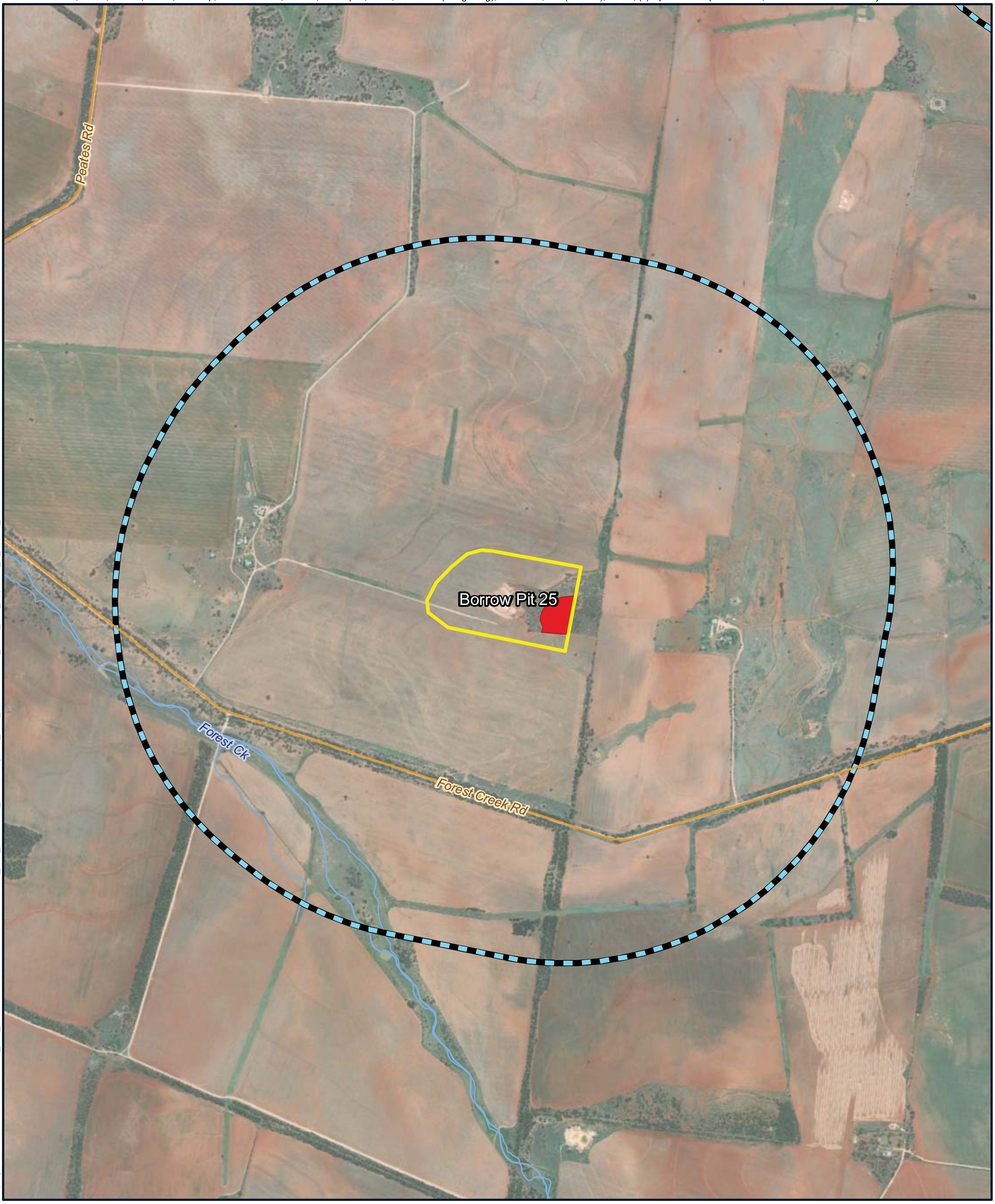


Legend

- Subject land
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

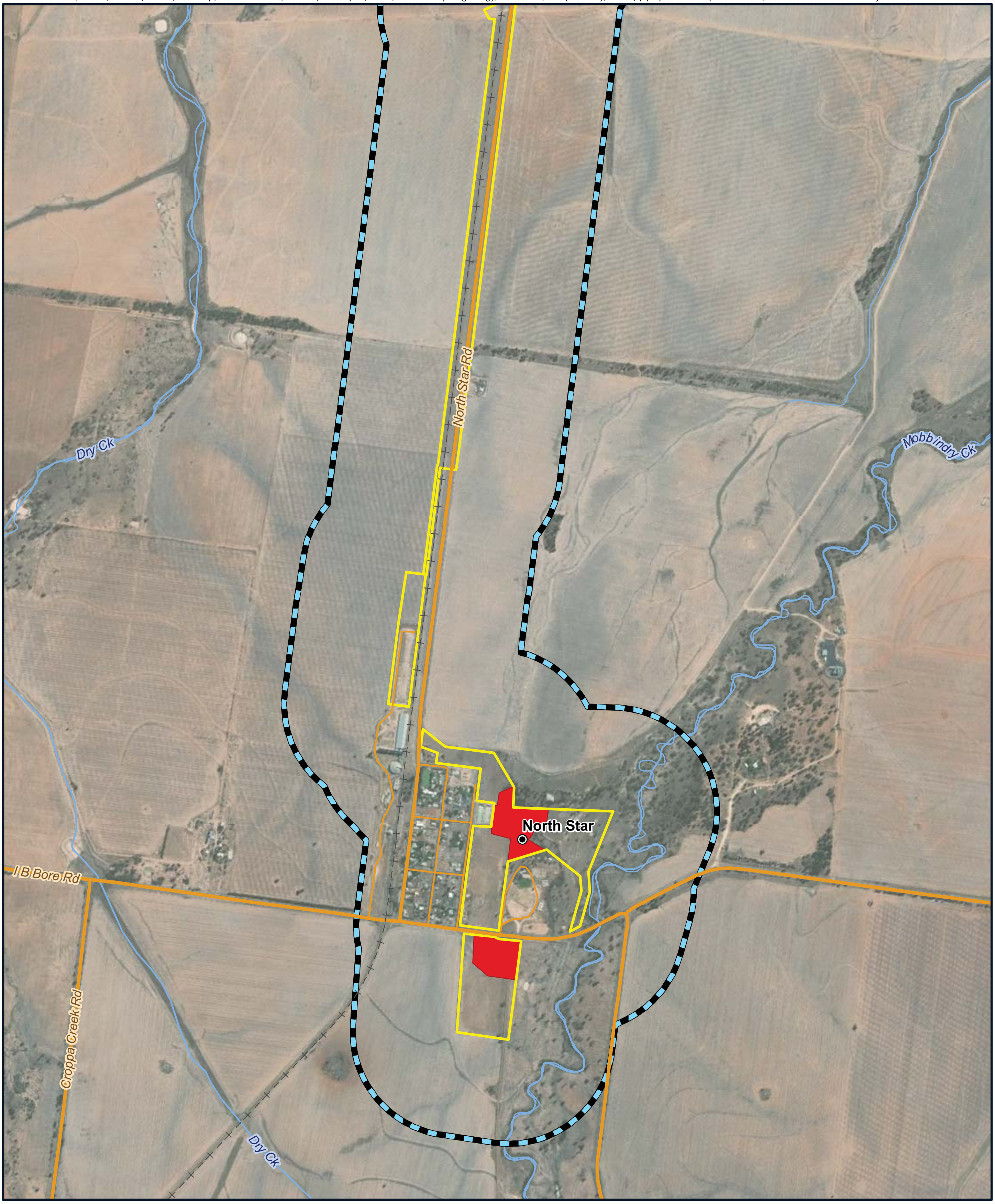
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Dunmall's snake (*Furina dunmalli*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Localities
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

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Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Painted honeyeater (*Grantiella picta*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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Legend

- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

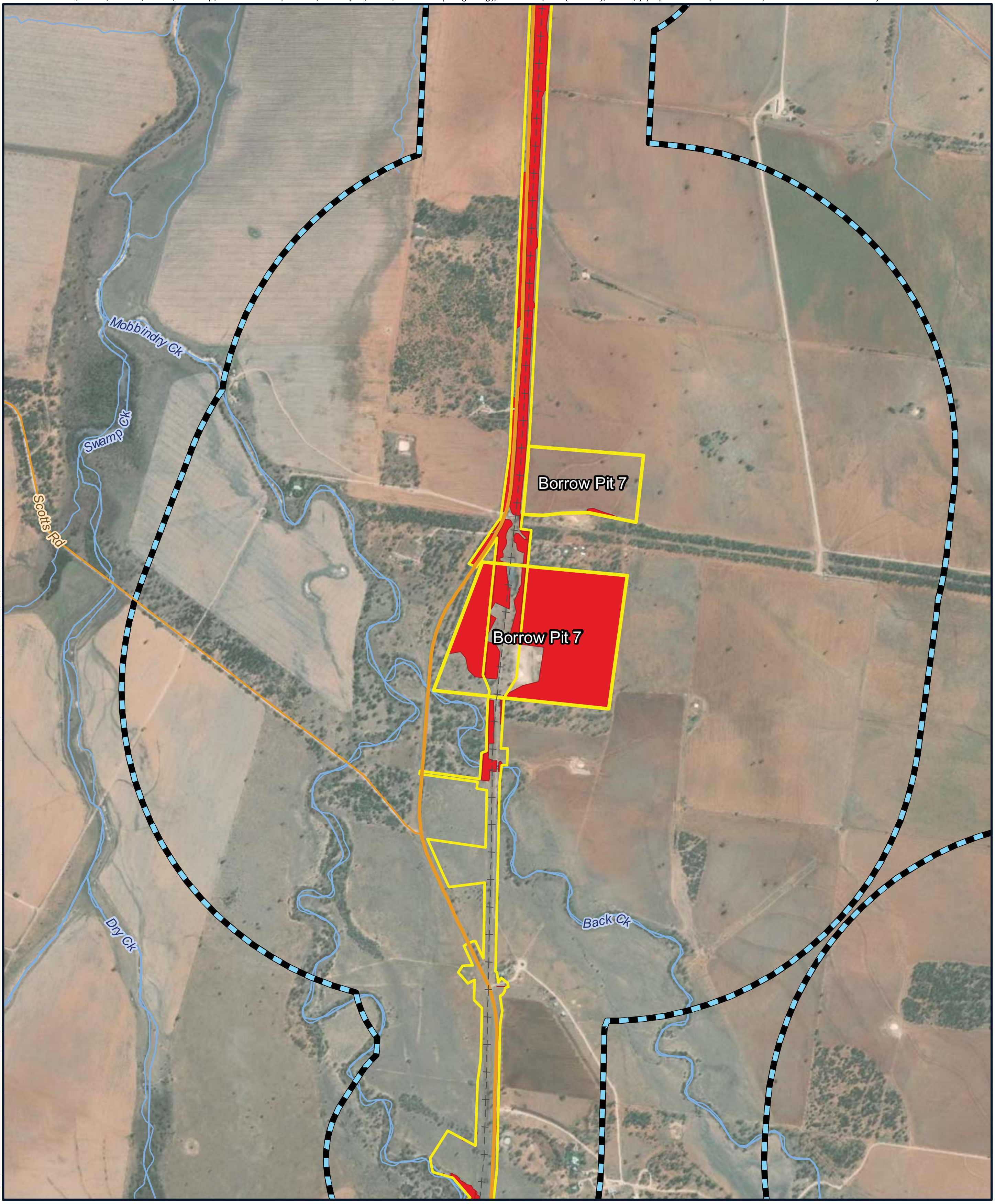
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Painted honeyeater (*Grantiella picta*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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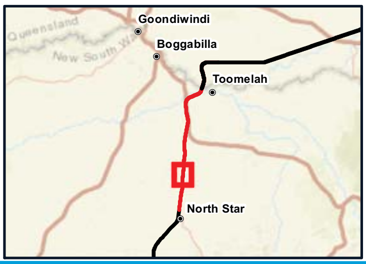
Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
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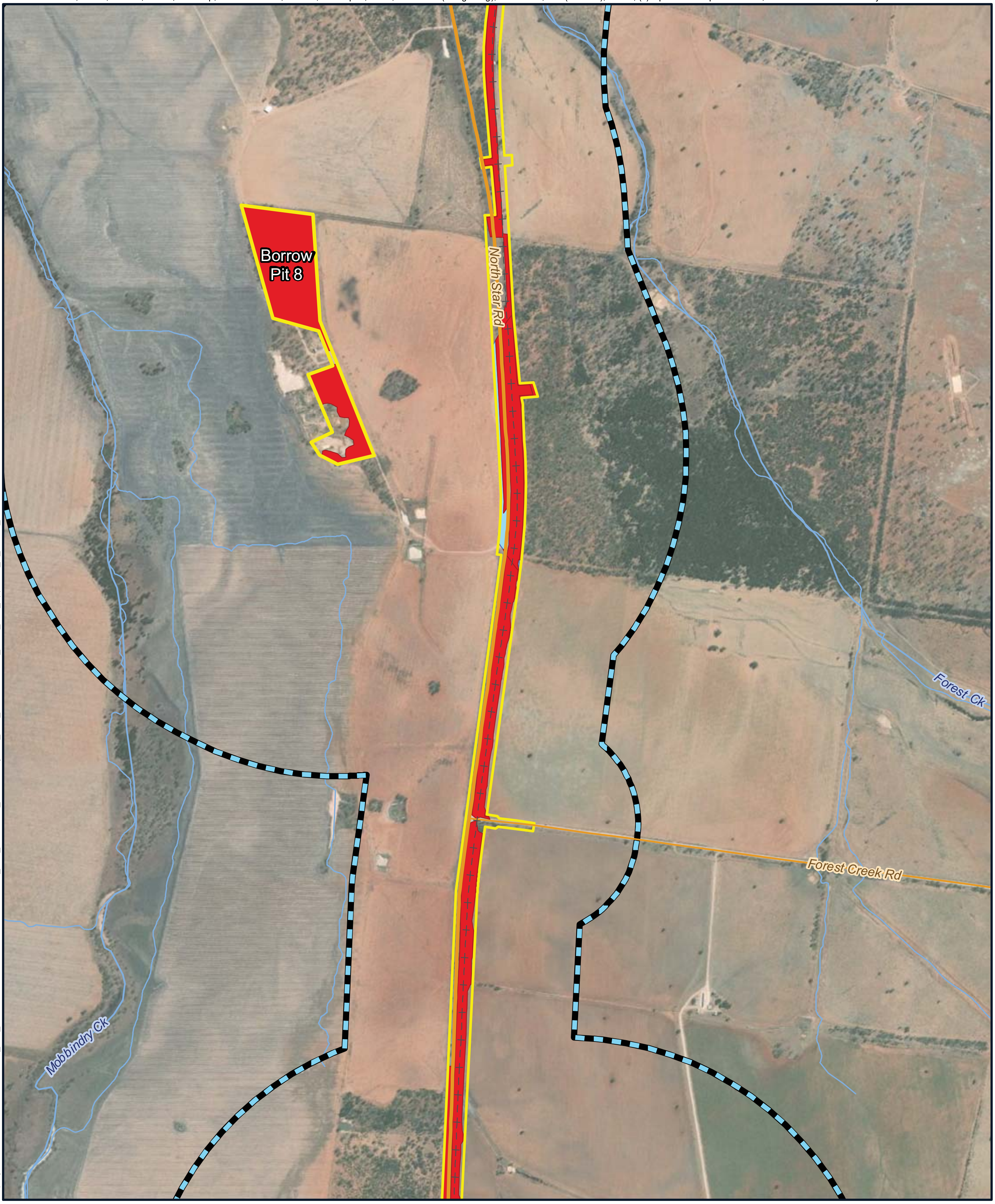
Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Painted honeyeater (*Grantiella picta*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

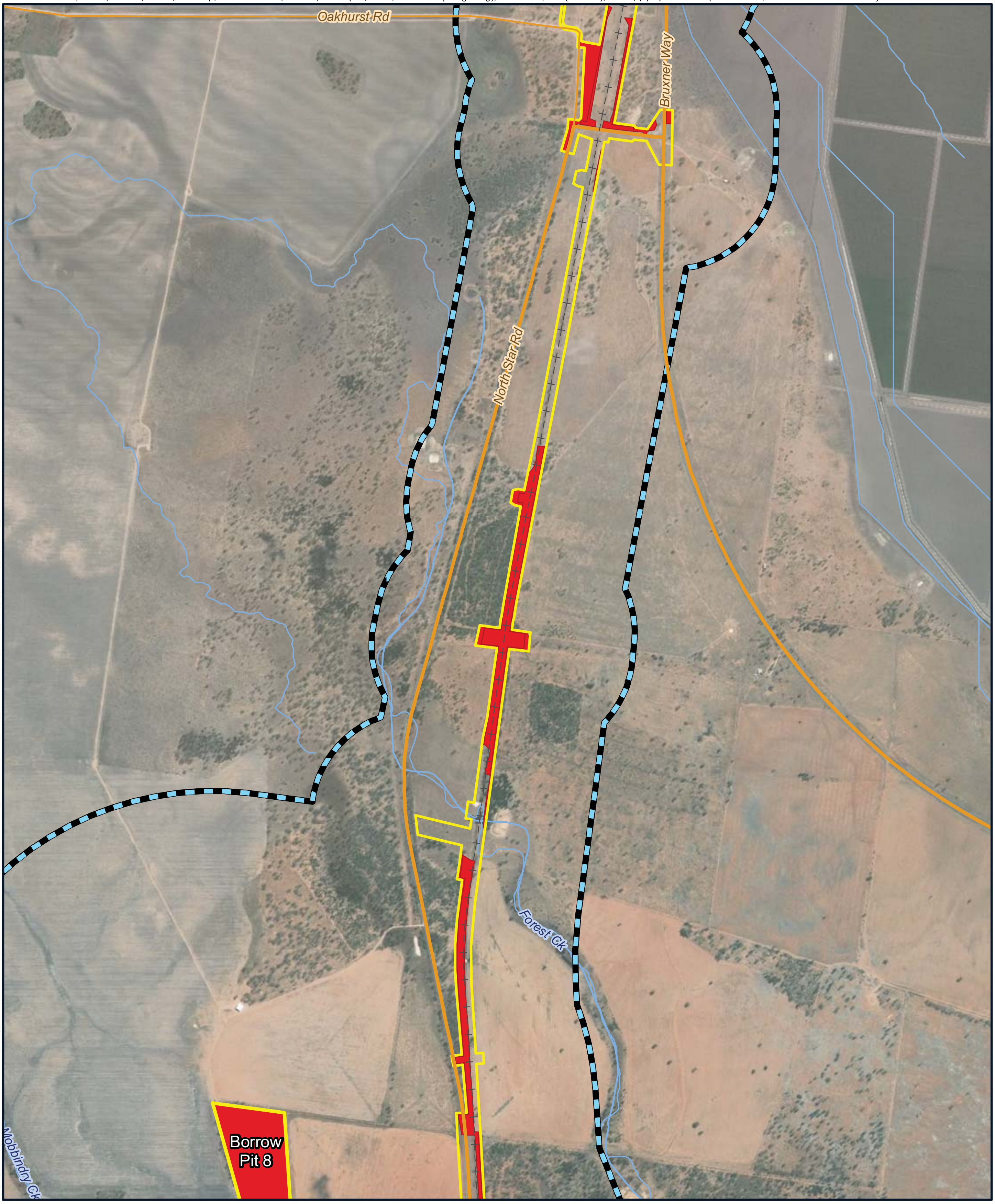
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Painted honeyeater (*Grantiella picta*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Painted honeyeater (*Grantiella picta*)

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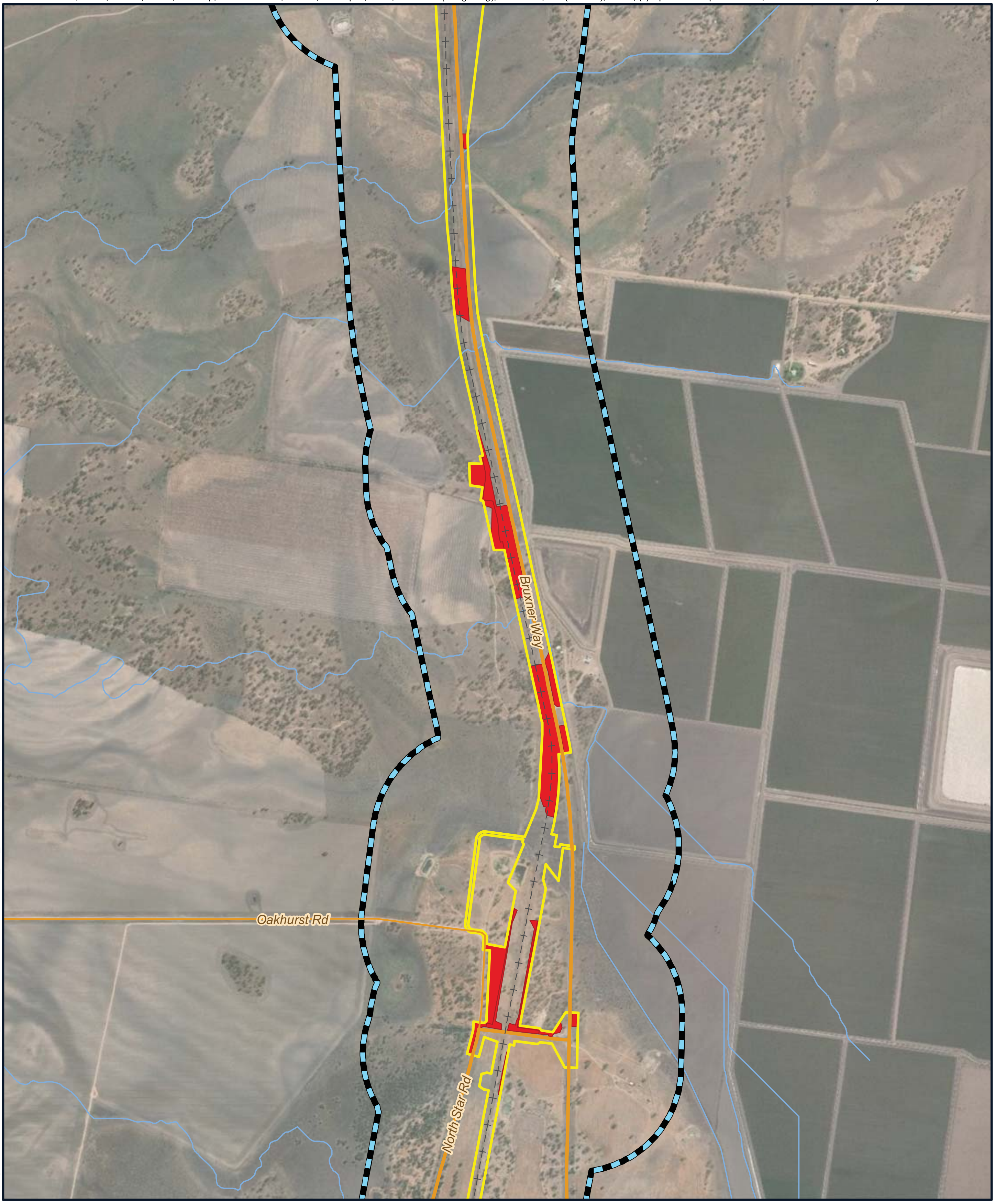

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Legend

- Existing rail (non-operational)
- Major roads
- Minor roads
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

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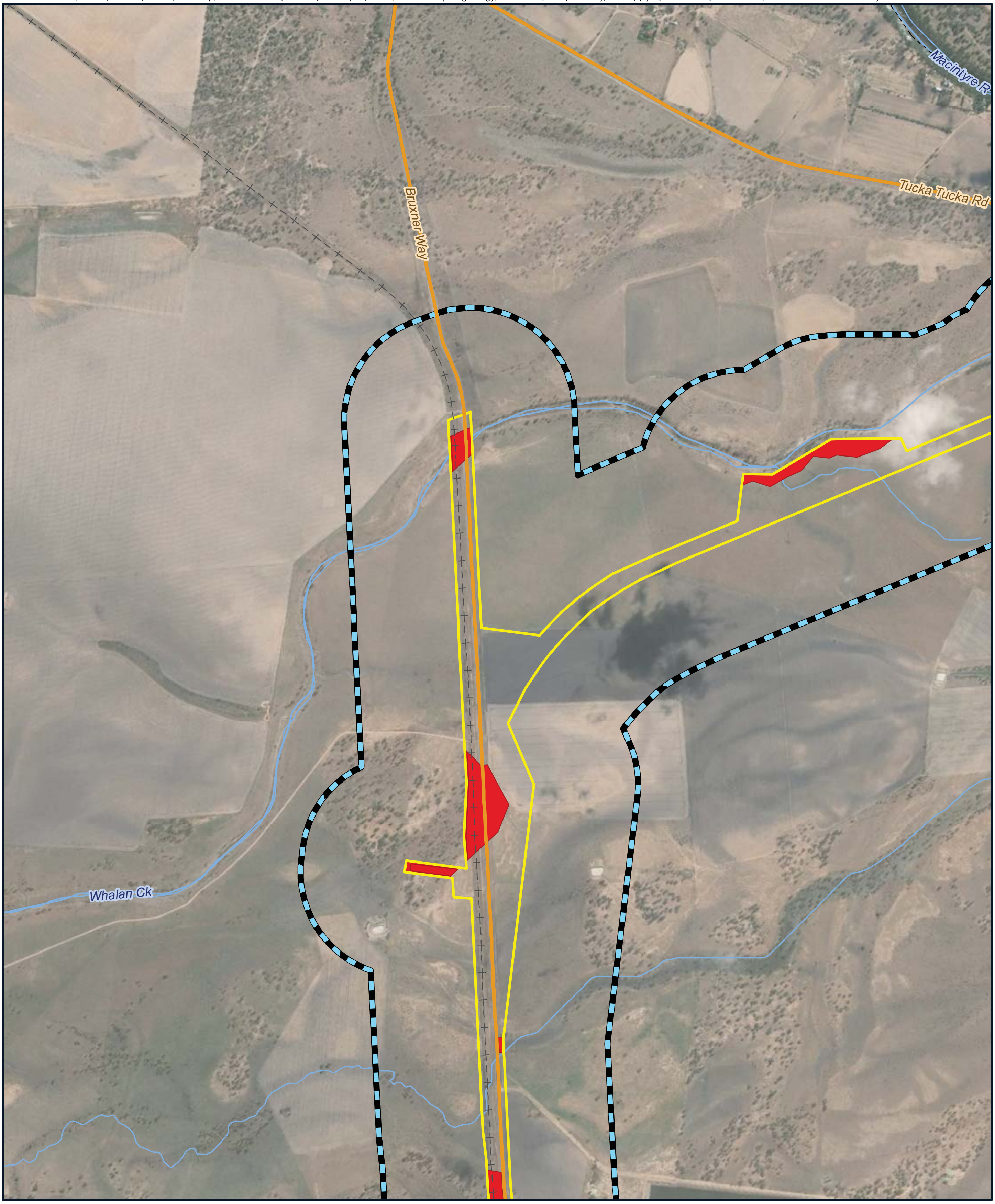

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Legend

- Existing rail (non-operational)
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

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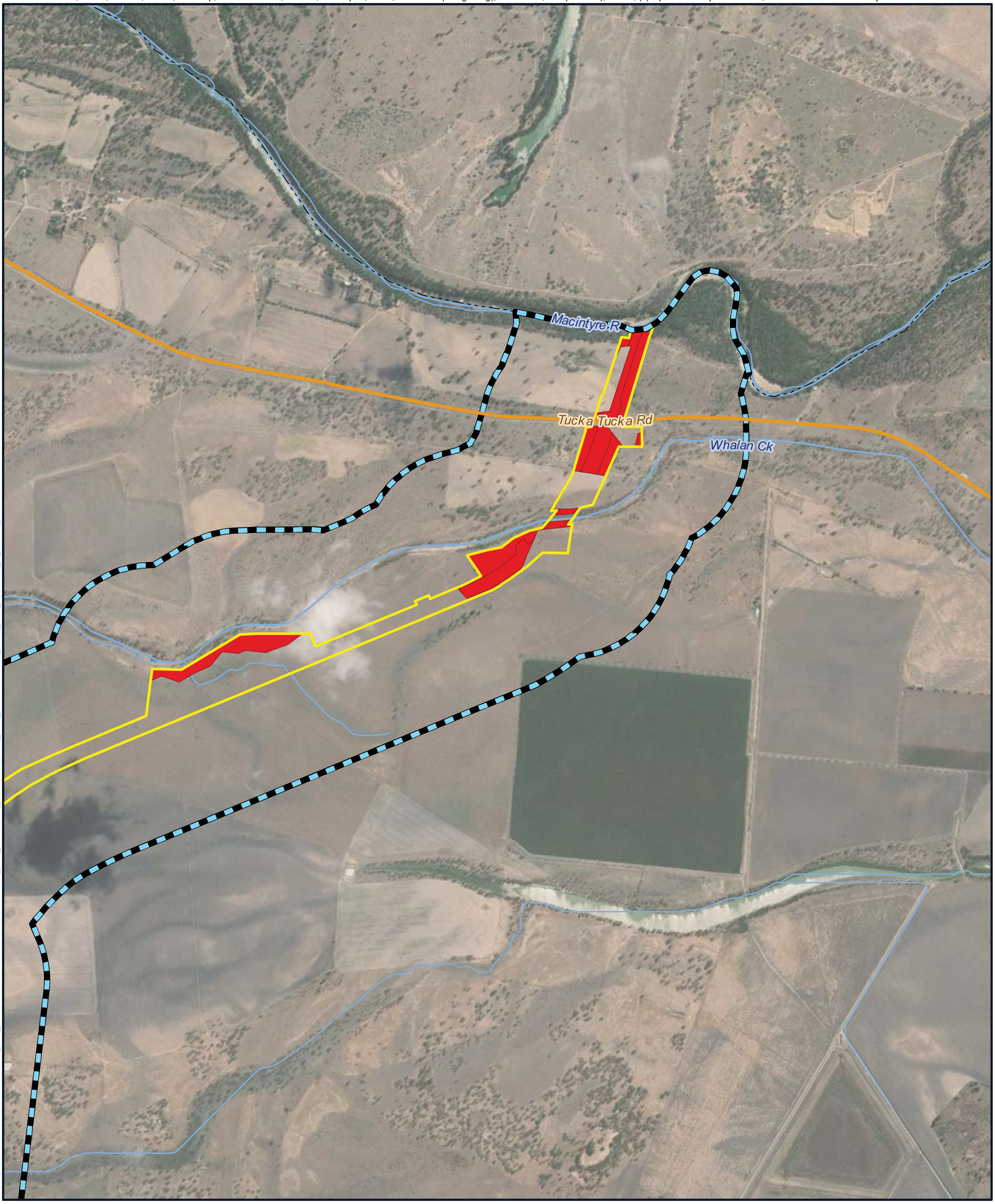

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Legend

Major roads
Watercourses
Study area
Subject land
Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

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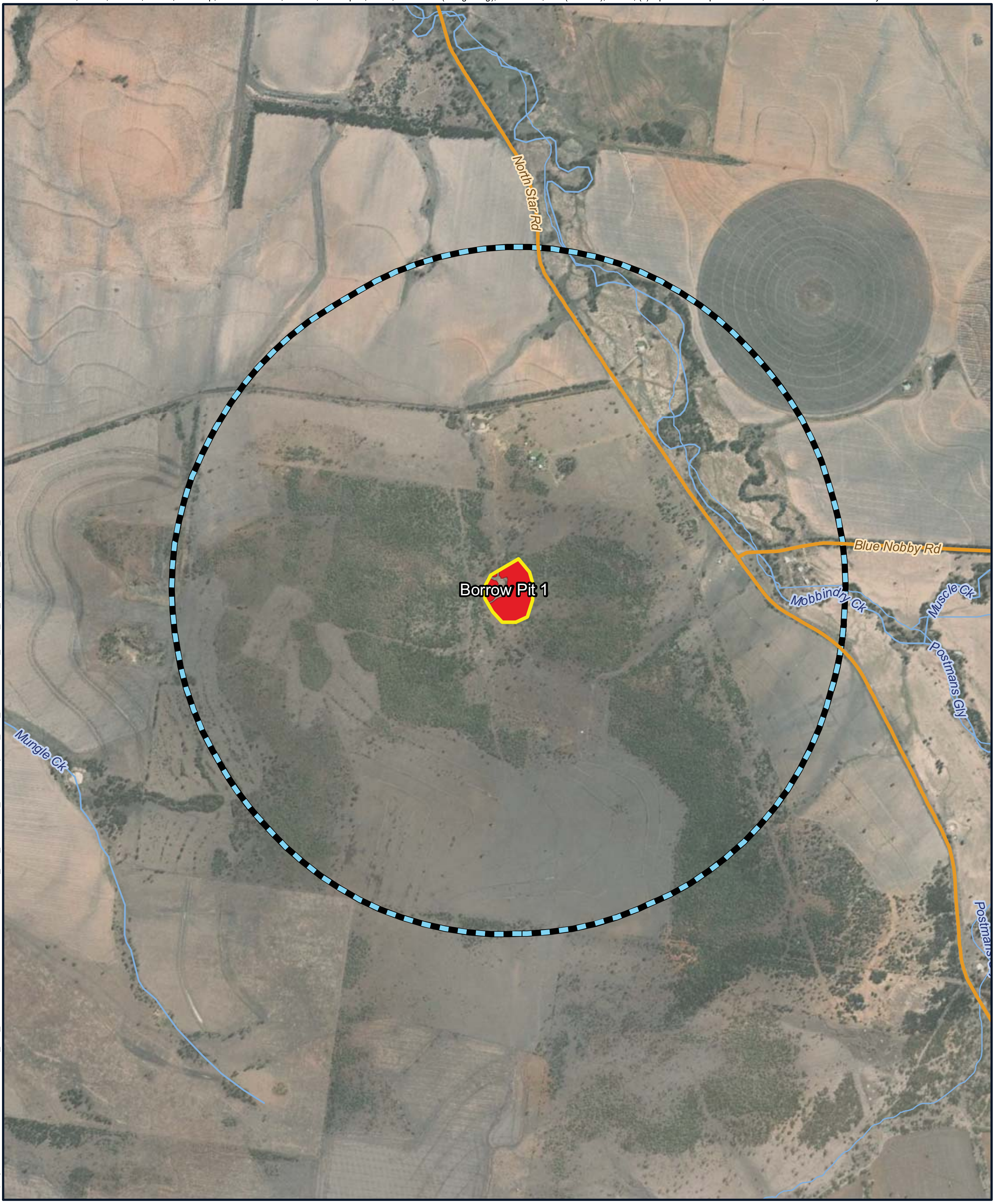
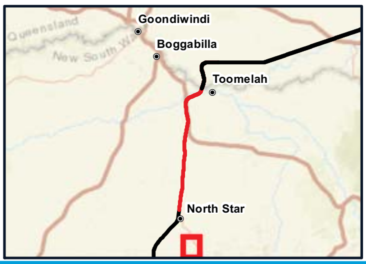


Legend

- Subject land
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

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Painted honeyeater (*Grantiella picta*)

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Legend

Subject land

Major roads

Watercourses

Study area

Subject land

Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

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Painted honeyeater (*Grantiella picta*)

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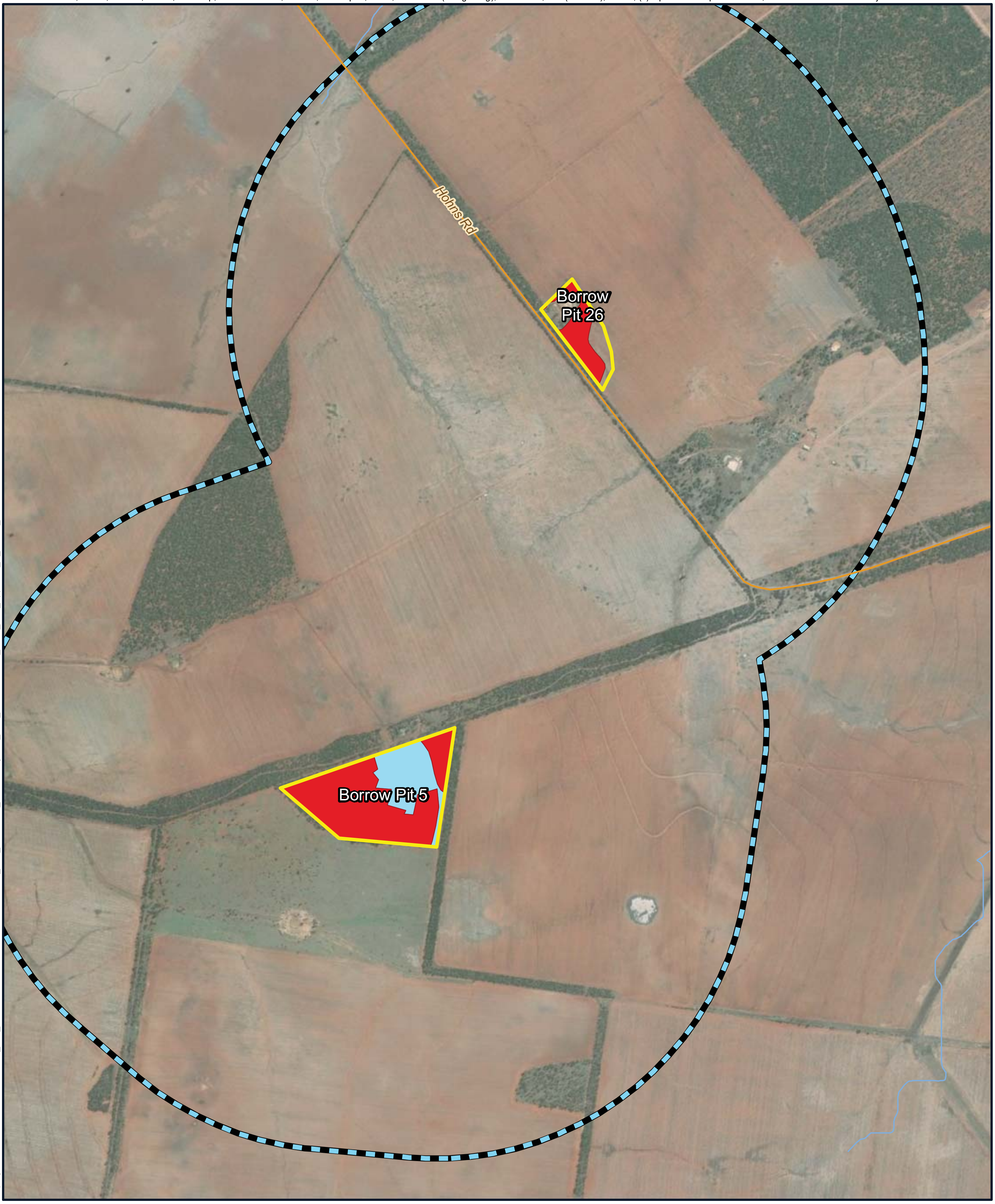

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Legend

- Subject land
- Minor roads
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Painted honeyeater (*Grantiella picta*)

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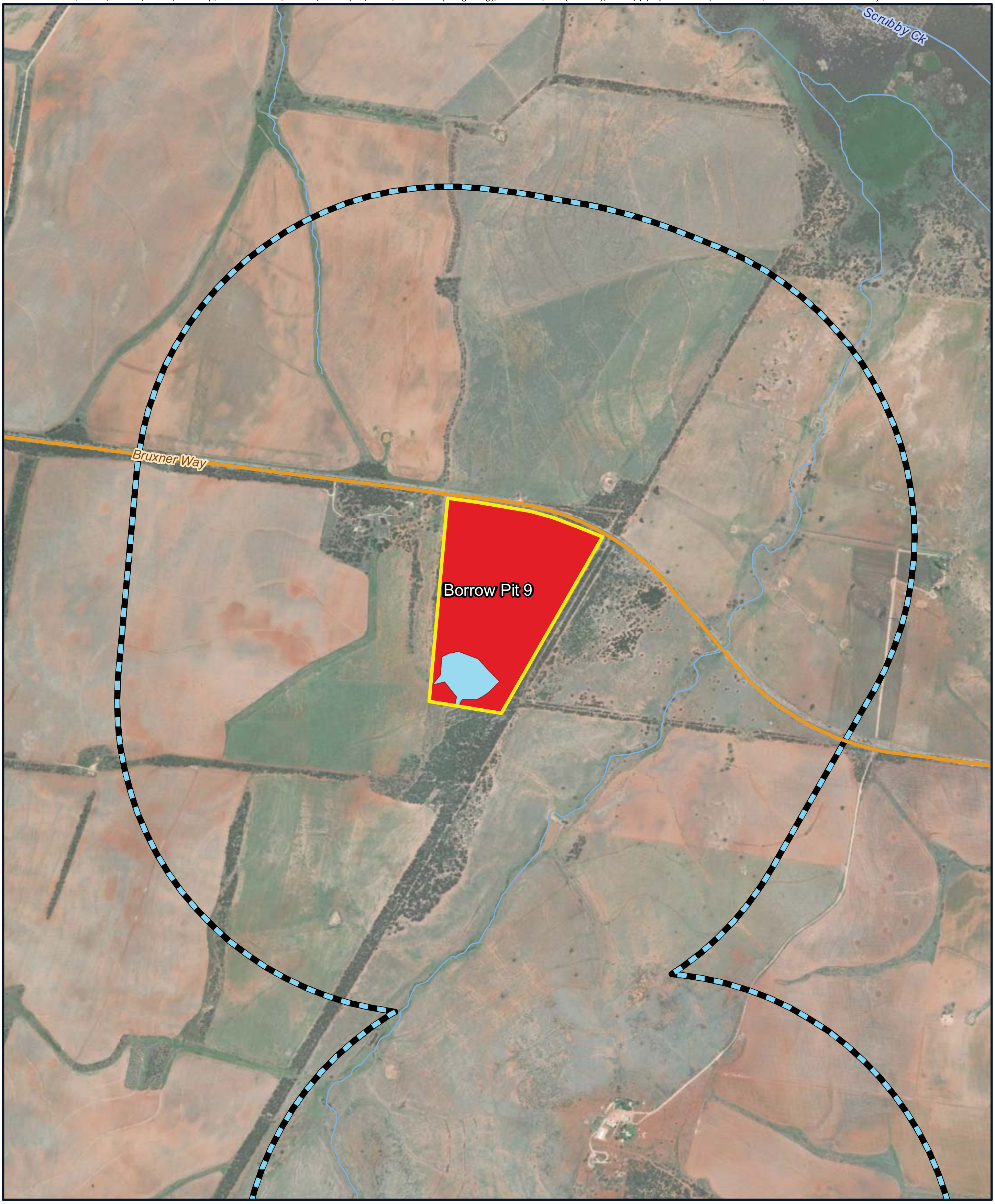

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Legend

- Subject land
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

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Painted honeyeater (*Grantiella picta*)

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Legend

- Subject land
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

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Legend

- Subject land
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Painted honeyeater (*Grantiella picta*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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Legend

- Subject land
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Painted honeyeater (*Grantiella picta*)

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Legend

- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

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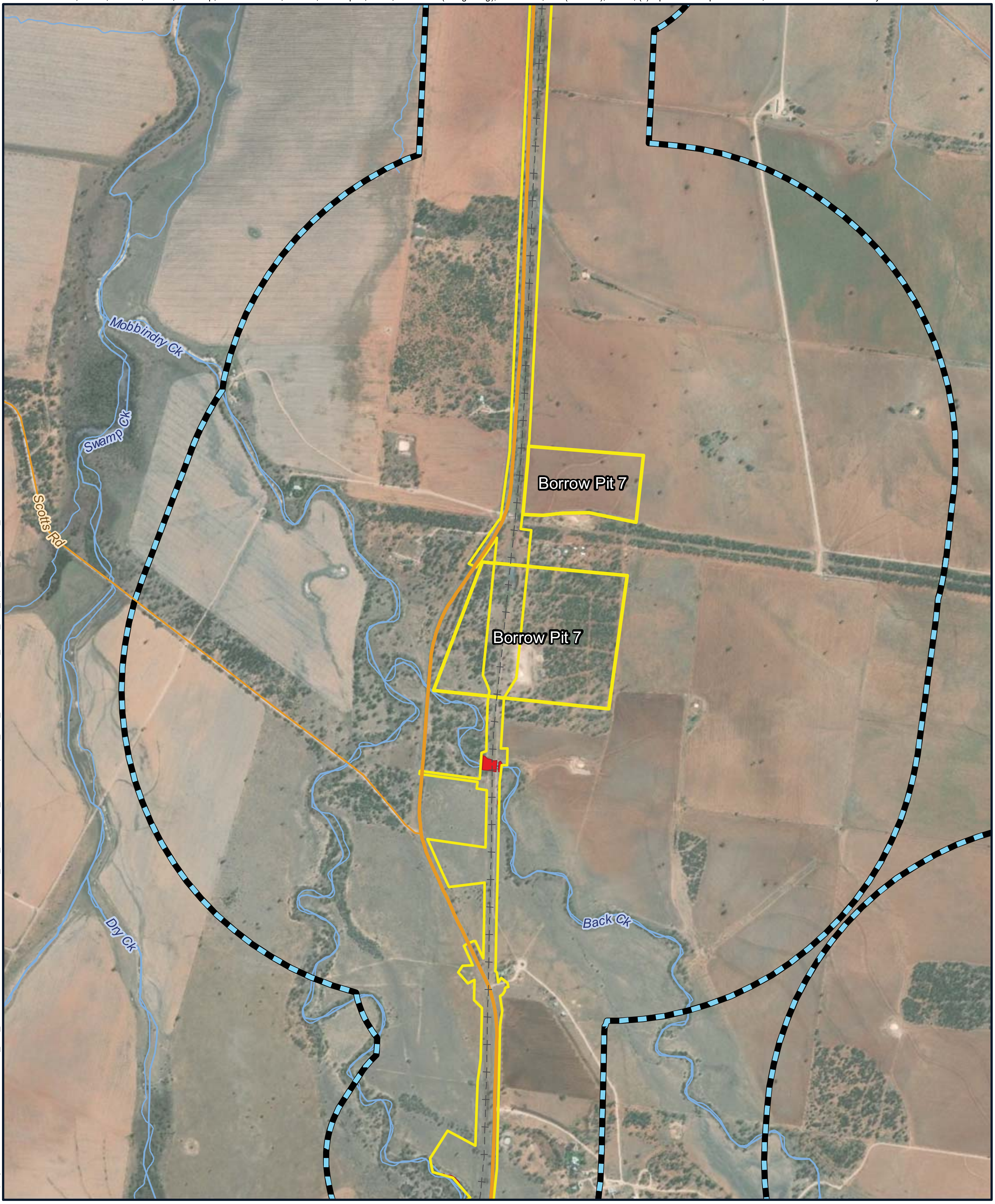
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Swift parrot (*Lathamus discolor*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Swift parrot (*Lathamus discolor*)

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Legend

- Existing rail (non-operational)
- Major roads
- Minor roads
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

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North Star to NSW/QLD border

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Swift parrot (*Lathamus discolor*)

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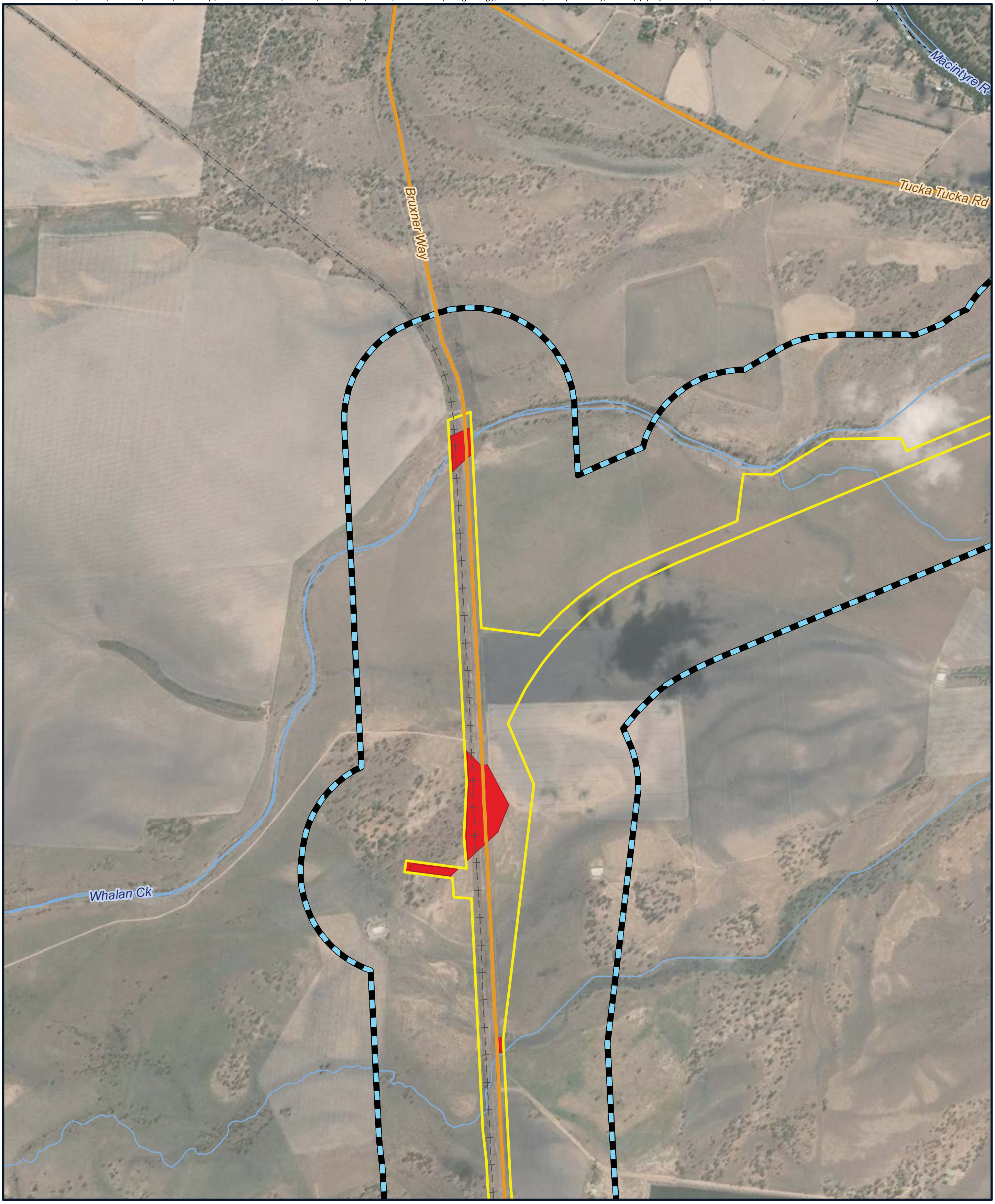

Legend

- Existing rail (non-operational)
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

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Swift parrot (*Lathamus discolor*)

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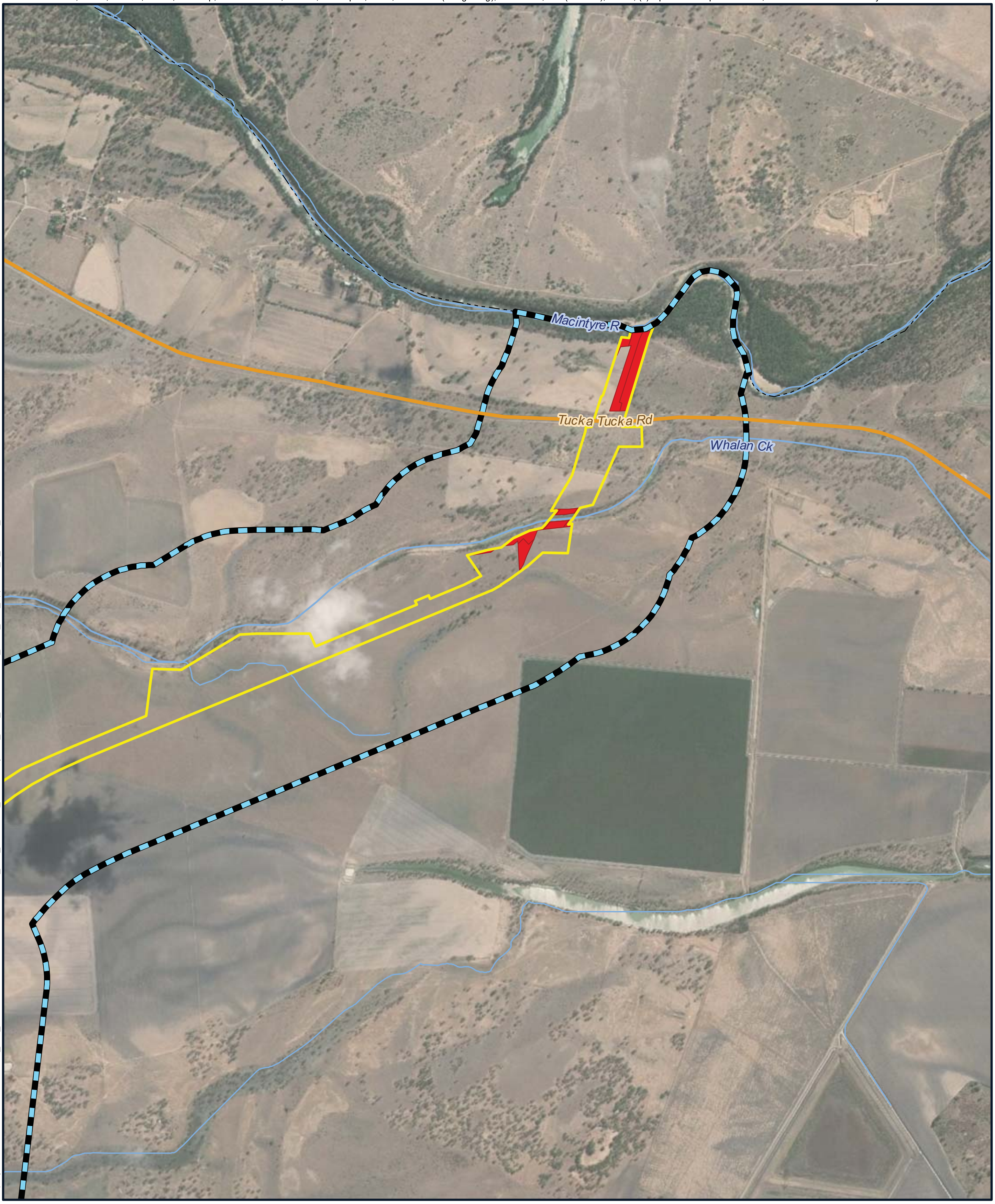

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Legend

- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Swift parrot (*Lathamus discolor*)

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Legend

Subject land
Major roads
Watercourses
Study area
Subject land
Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

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North Star to NSW/QLD border

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Swift parrot (*Lathamus discolor*)

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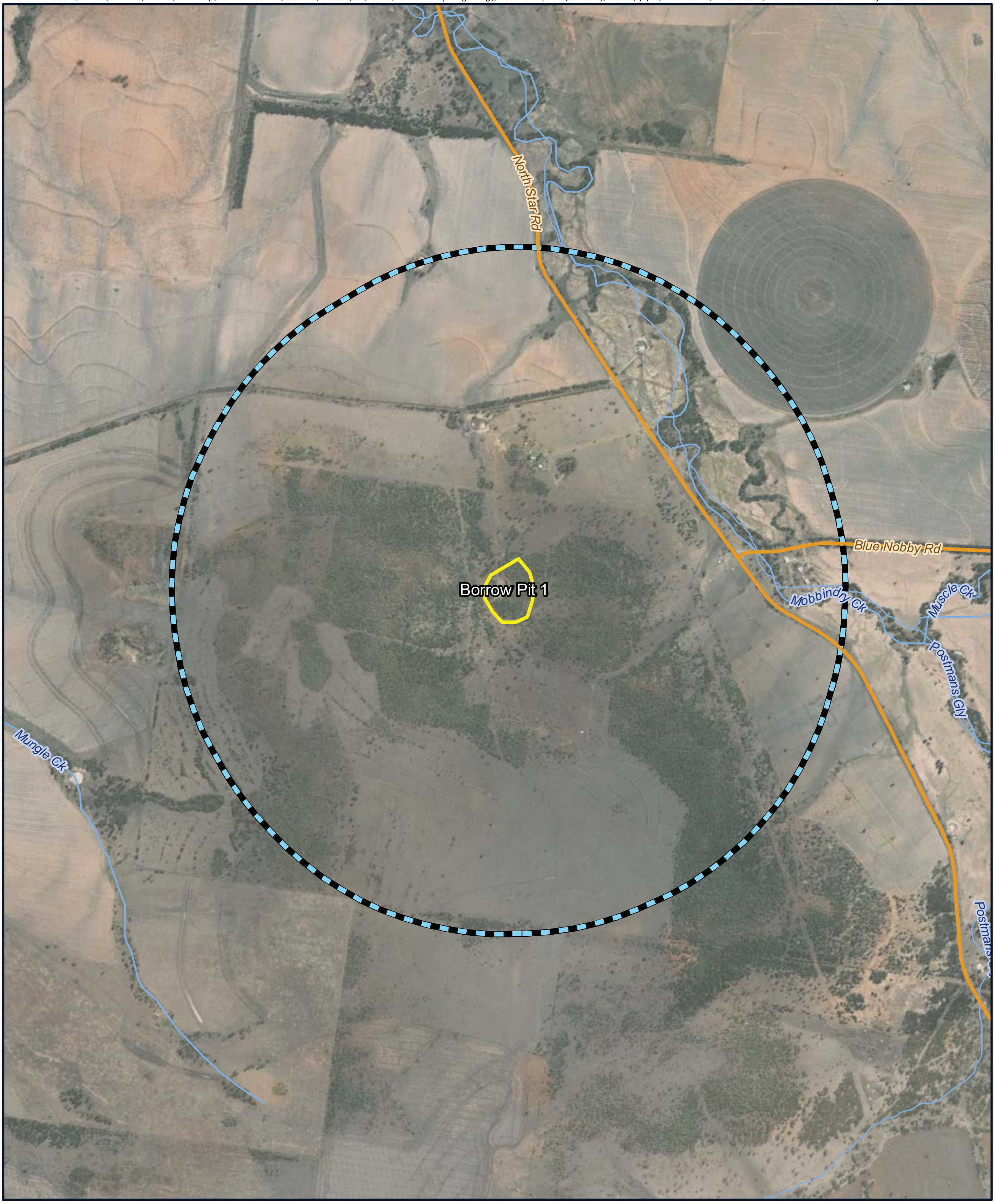

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Legend

- Subject land
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

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North Star to NSW/QLD border

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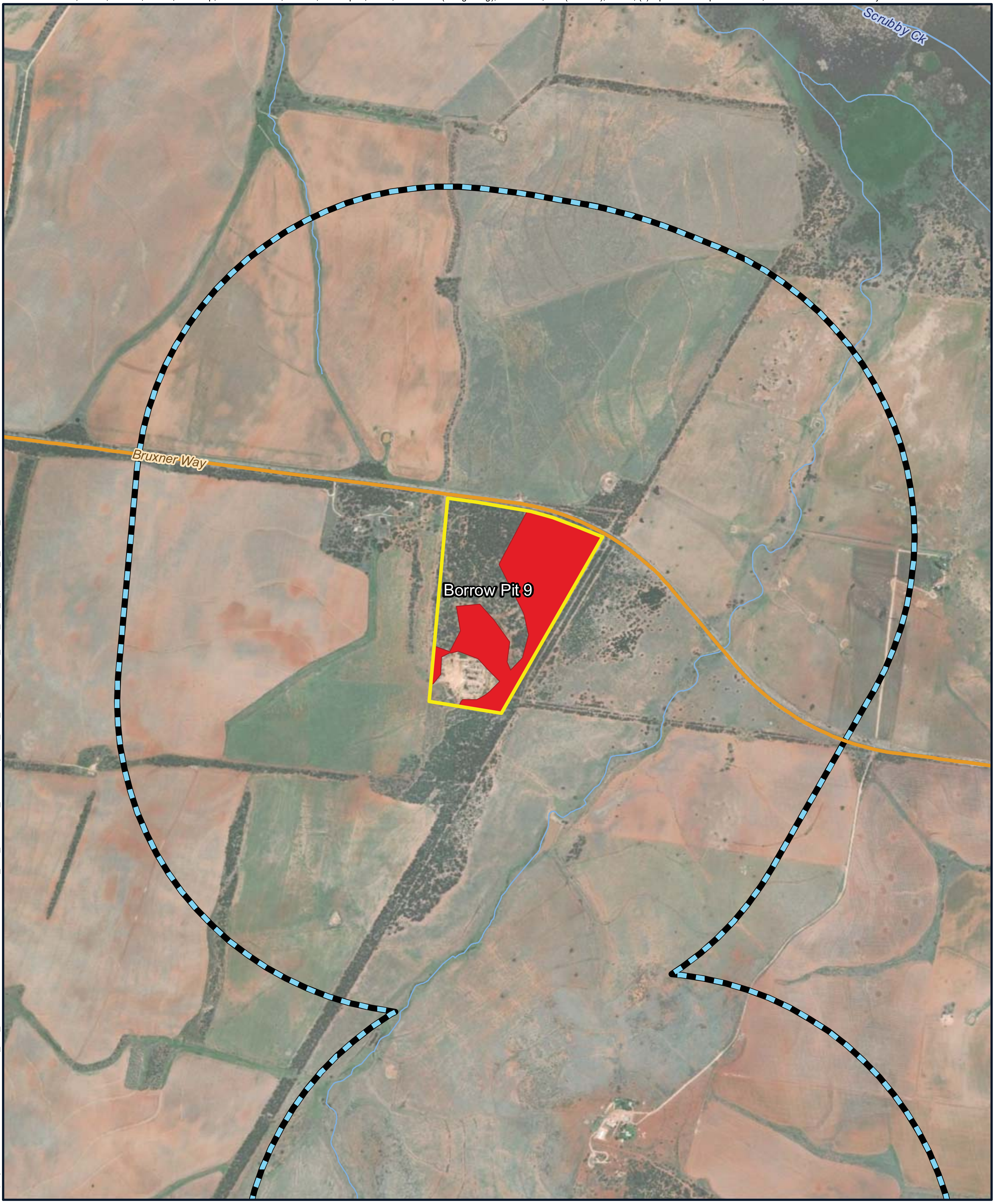

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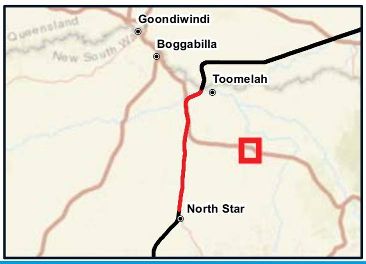
Legend

- Subject land
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat



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0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

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North Star to NSW/QLD border

Appendix C AIAMs output: Swift parrot (*Lathamus discolor*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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Legend

- Subject land
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

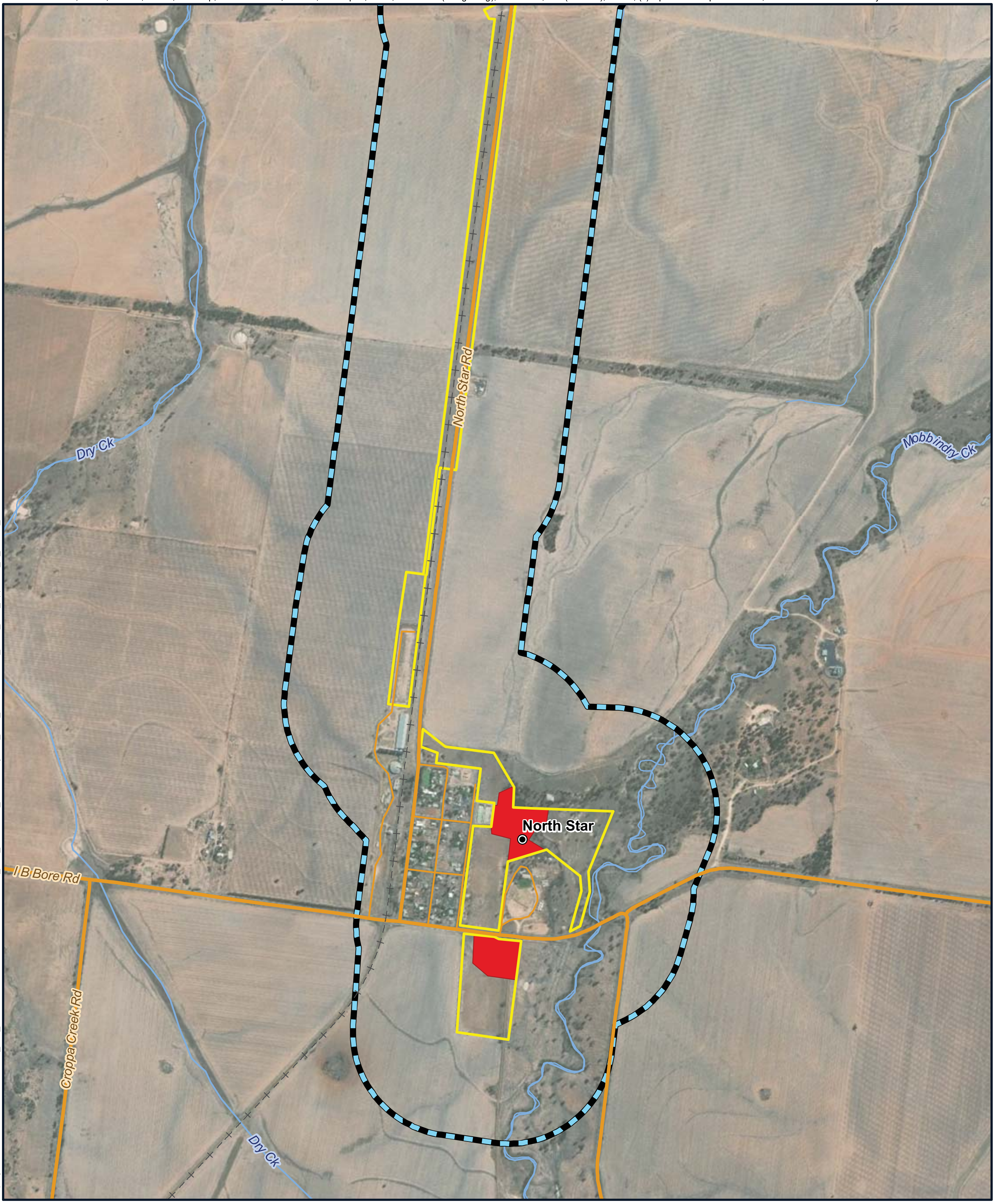
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Swift parrot (*Lathamus discolor*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Localities
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Corben's long-eared bat (*Nyctophilus corbeni*)

Map by: RB/MF/DTH/MF Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-202007011428_GIS_Terrestrial_biodiversity\270_EAP_202007011428_FFJV_A4P_Appendix_C_AIAMs_Fauna.mxd Date: 14/07/2020 16:42

Legend

- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

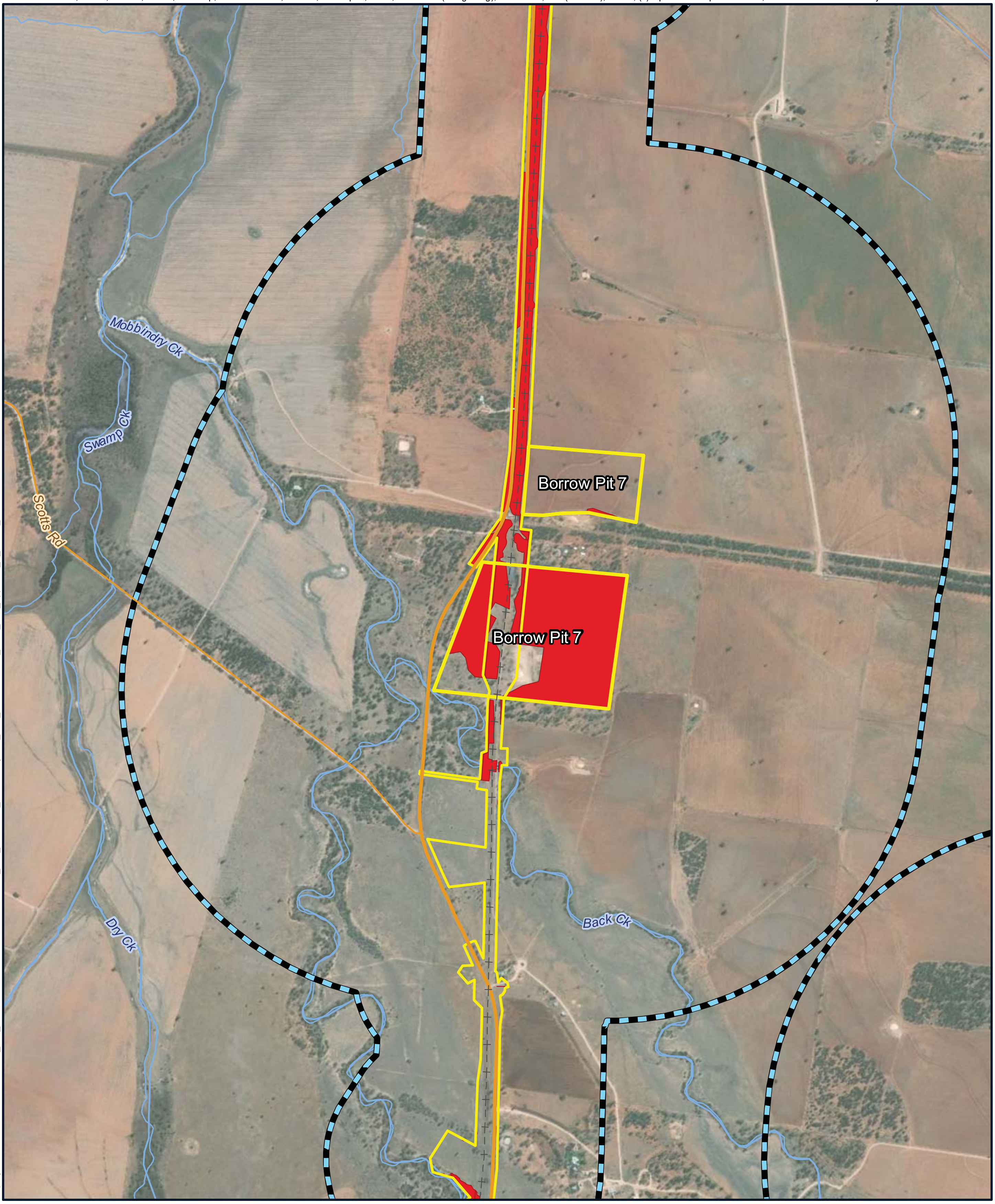
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Corben's long-eared bat (*Nyctophilus corbeni*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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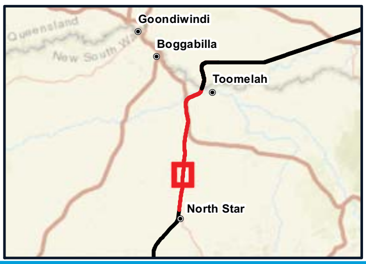
Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

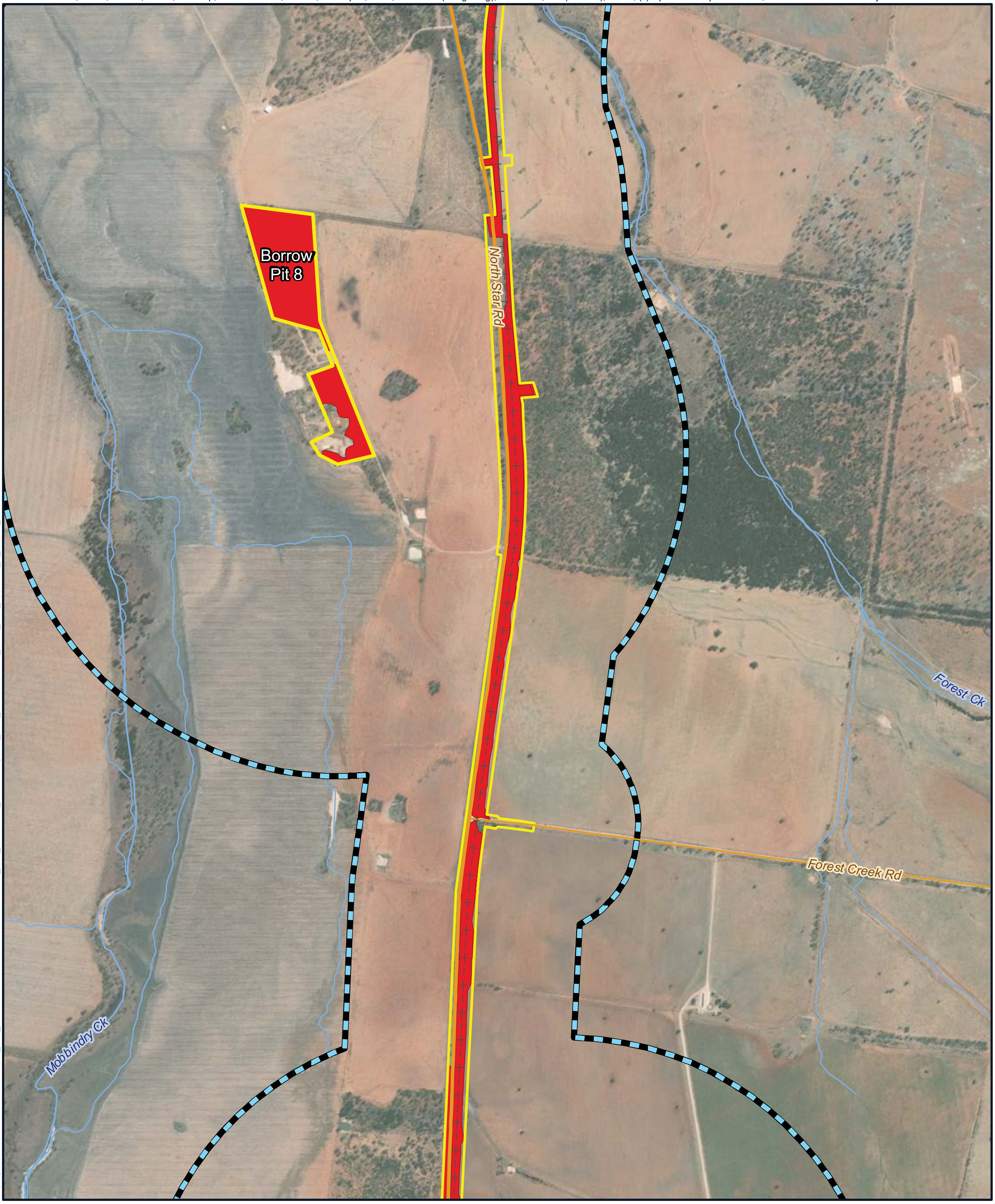
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Corben's long-eared bat (*Nyctophilus corbeni*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

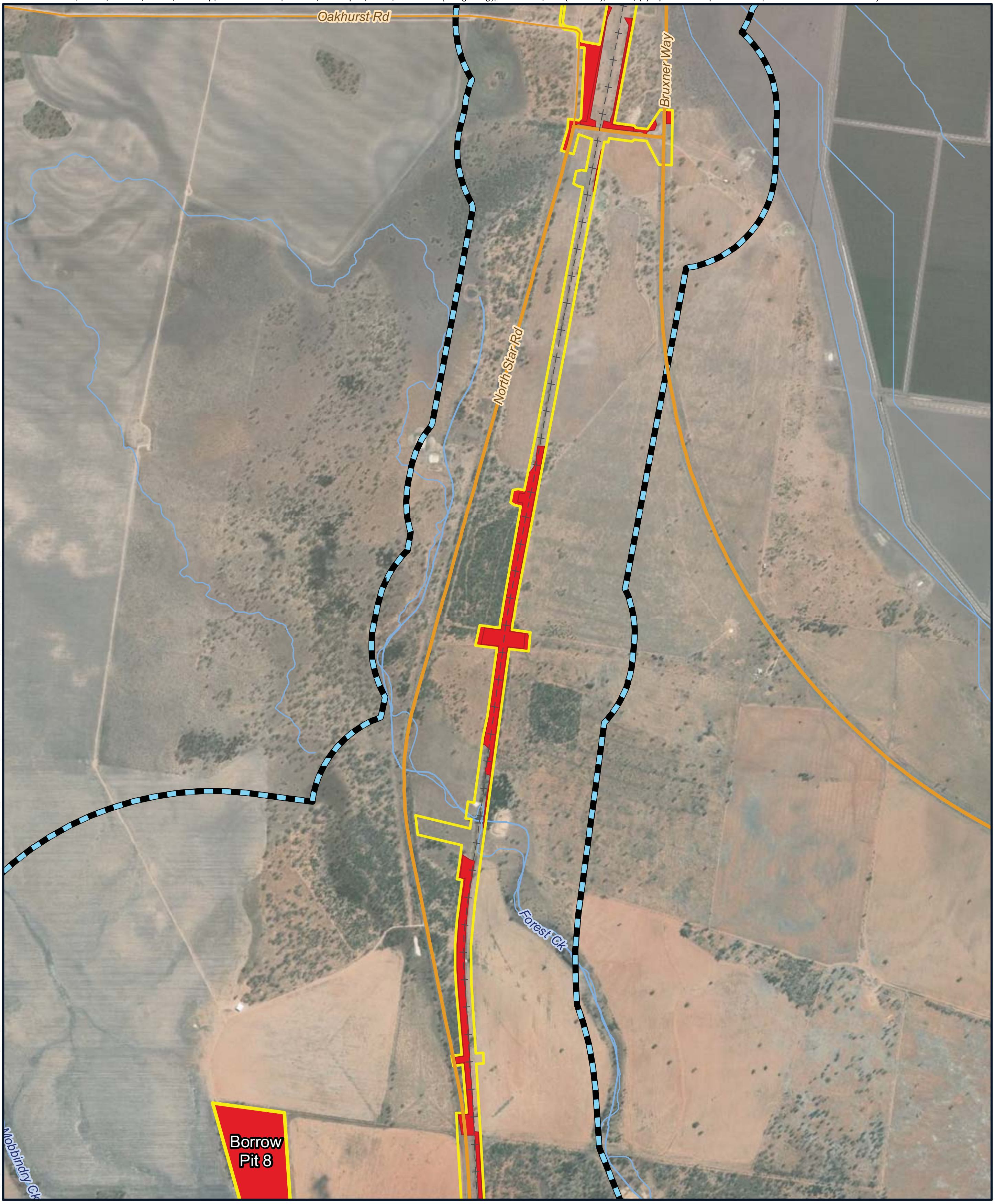
0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Corben's long-eared bat (*Nyctophilus corbeni*)



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Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

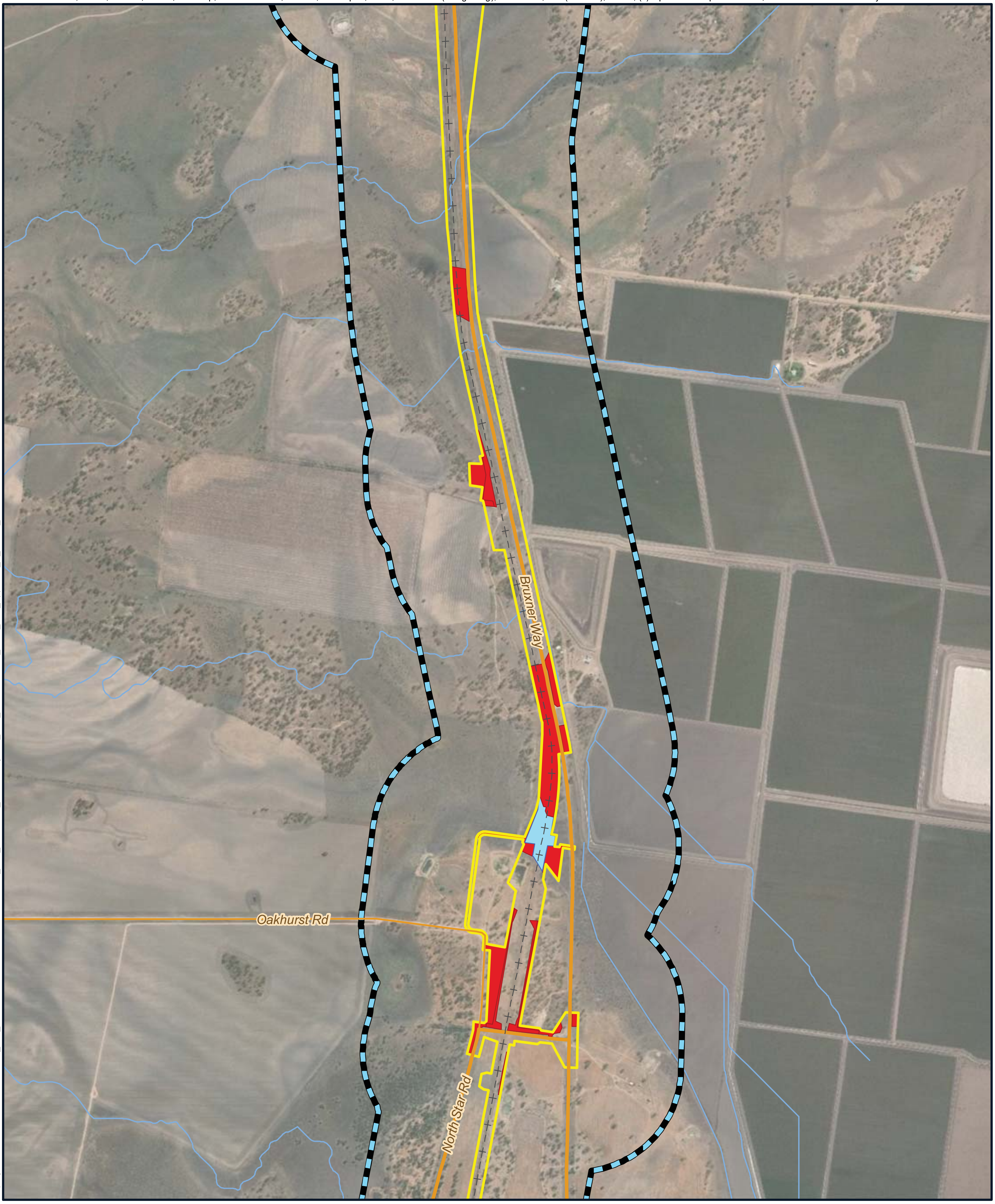
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Corben's long-eared bat (*Nyctophilus corbeni*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Existing rail (non-operational)
- Major roads
- Minor roads
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Corben's long-eared bat (*Nyctophilus corbeni*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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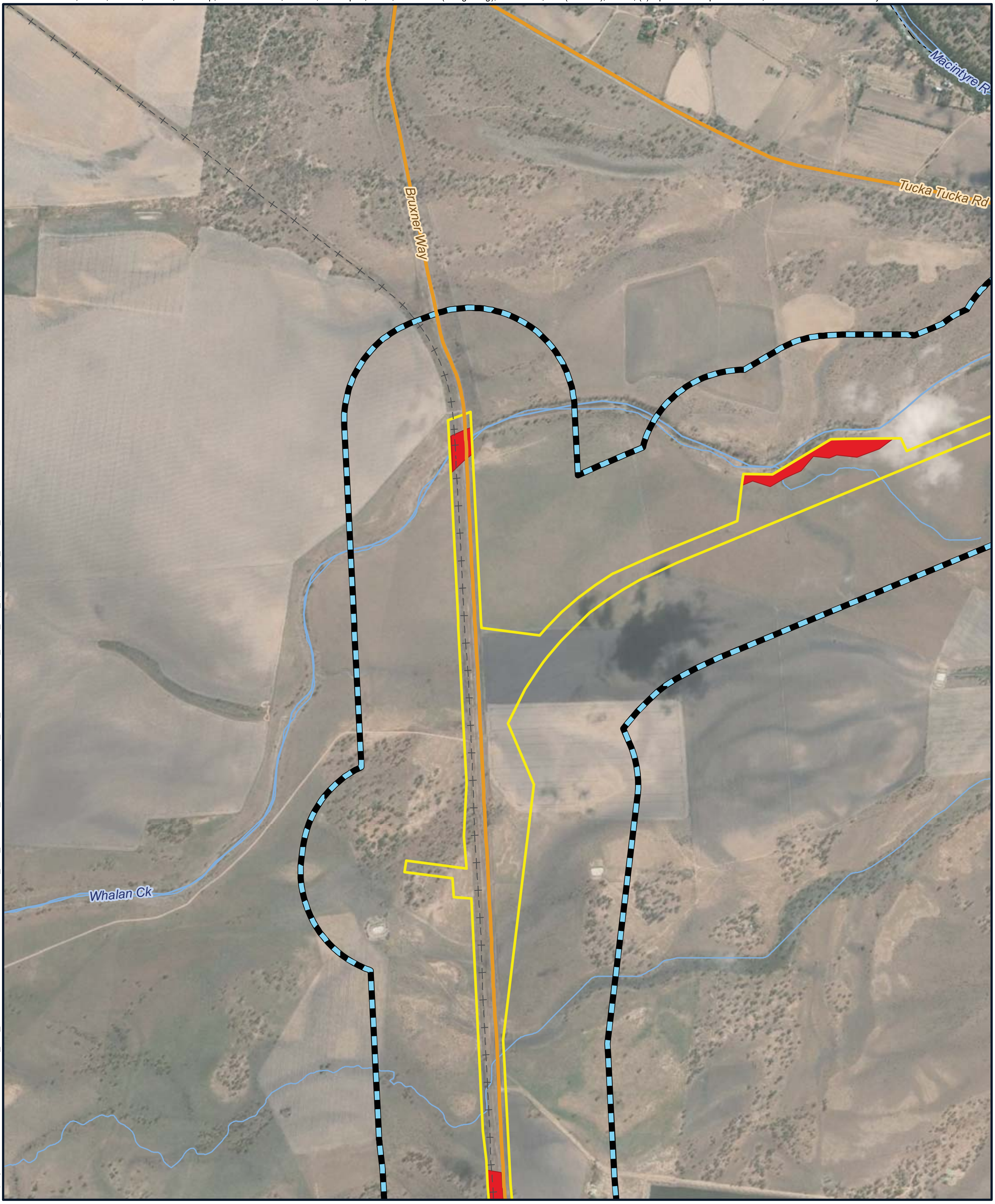


Legend

- Existing rail (non-operational)
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

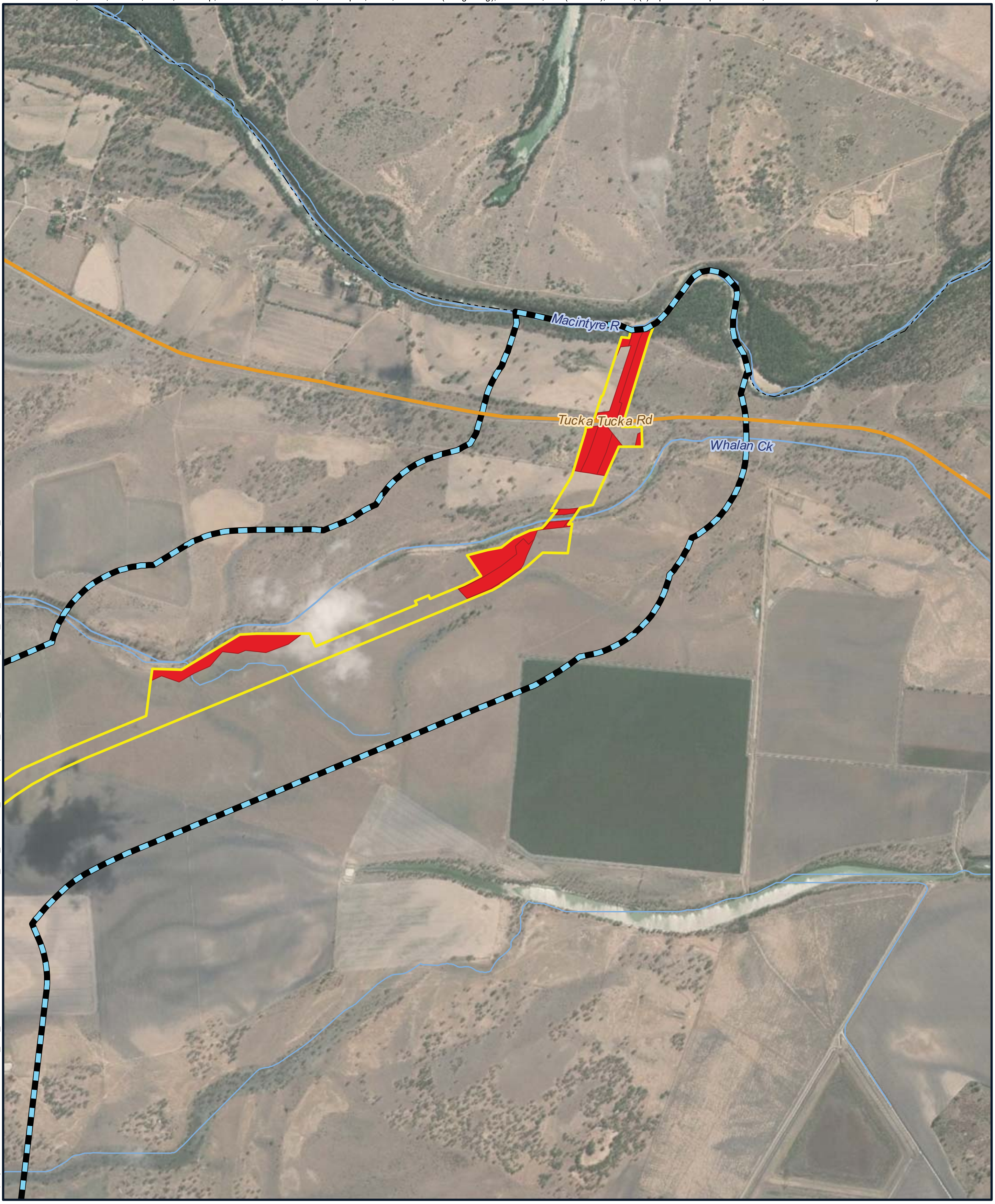
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Corben's long-eared bat (*Nyctophilus corbeni*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

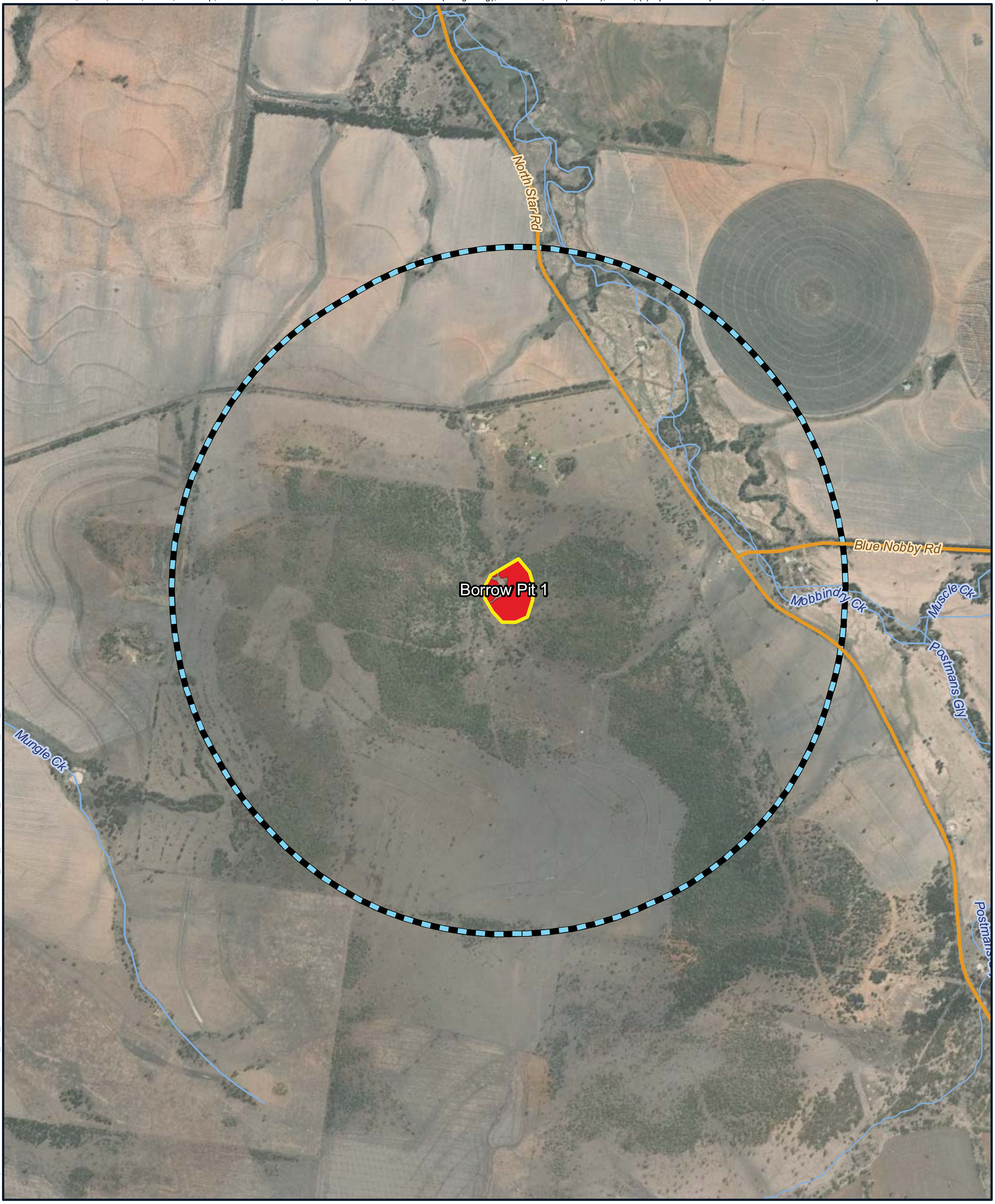
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Corben's long-eared bat (*Nyctophilus corbeni*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Subject land
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Corben's long-eared bat (*Nyctophilus corbeni*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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Legend

- Subject land
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Corben's long-eared bat (*Nyctophilus corbeni*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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Legend

Subject land
Minor roads
Study area
Subject land
Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

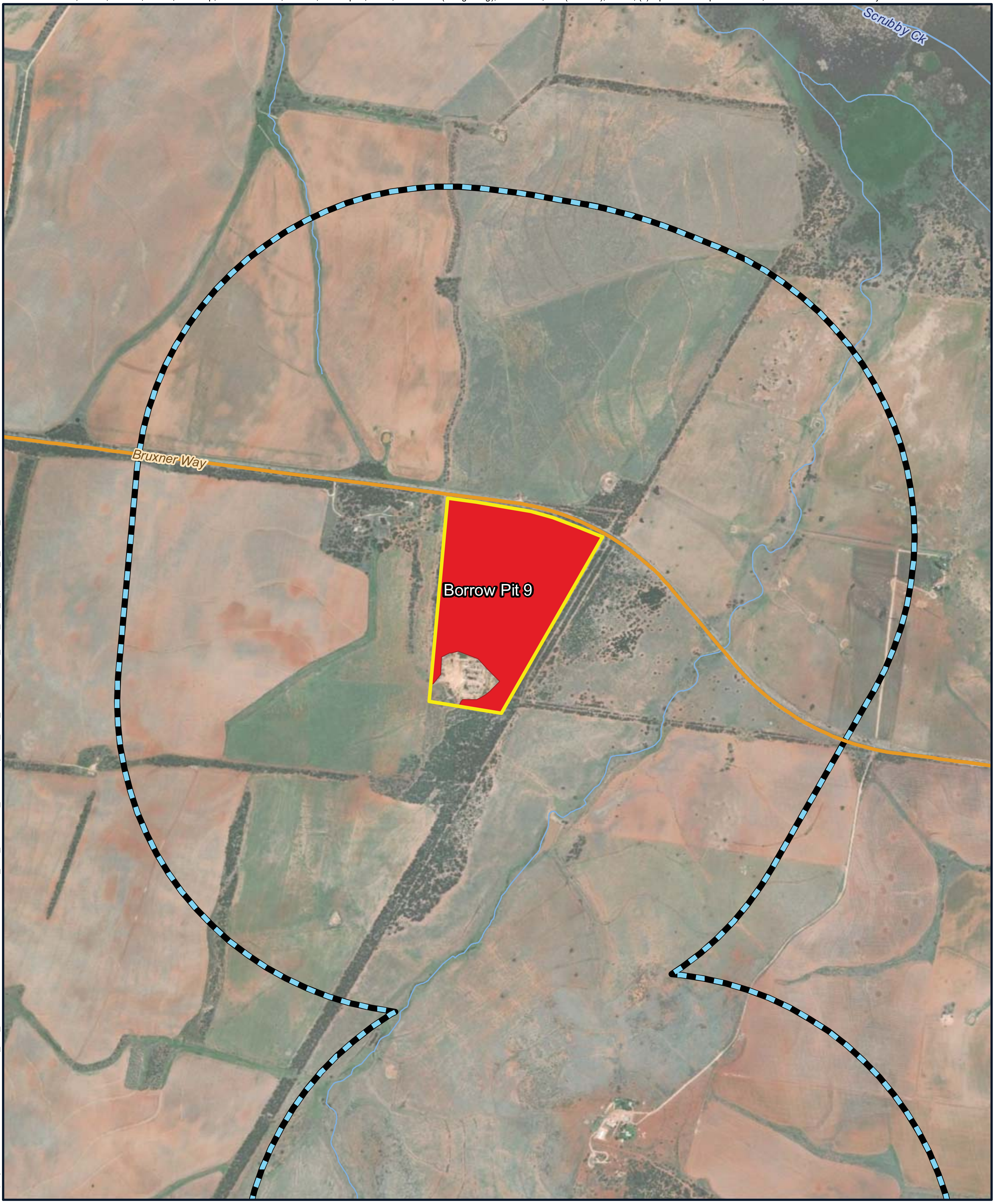
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Corben's long-eared bat (*Nyctophilus corbeni*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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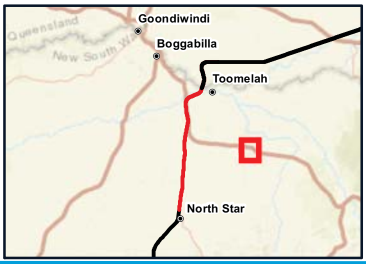
Legend

- Subject land
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Corben's long-eared bat (*Nyctophilus corbeni*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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Legend

- Subject land
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Corben's long-eared bat (*Nyctophilus corbeni*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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Legend

- Subject land
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Corben's long-eared bat (*Nyctophilus corbeni*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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Legend

- Subject land
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

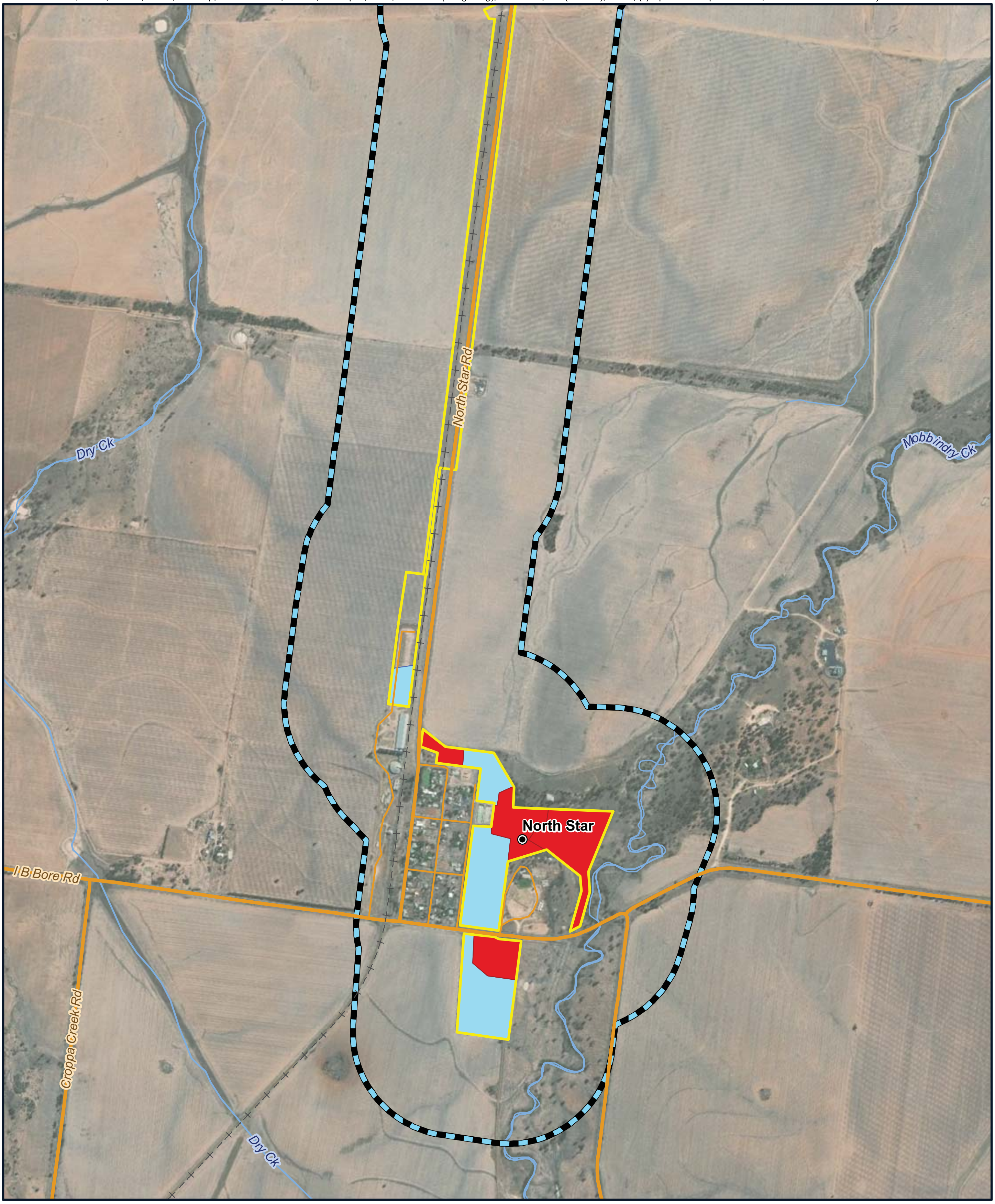
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Corben's long-eared bat (*Nyctophilus corbeni*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Localities
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Koala (*Phascolarctos cinereus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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Legend

- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

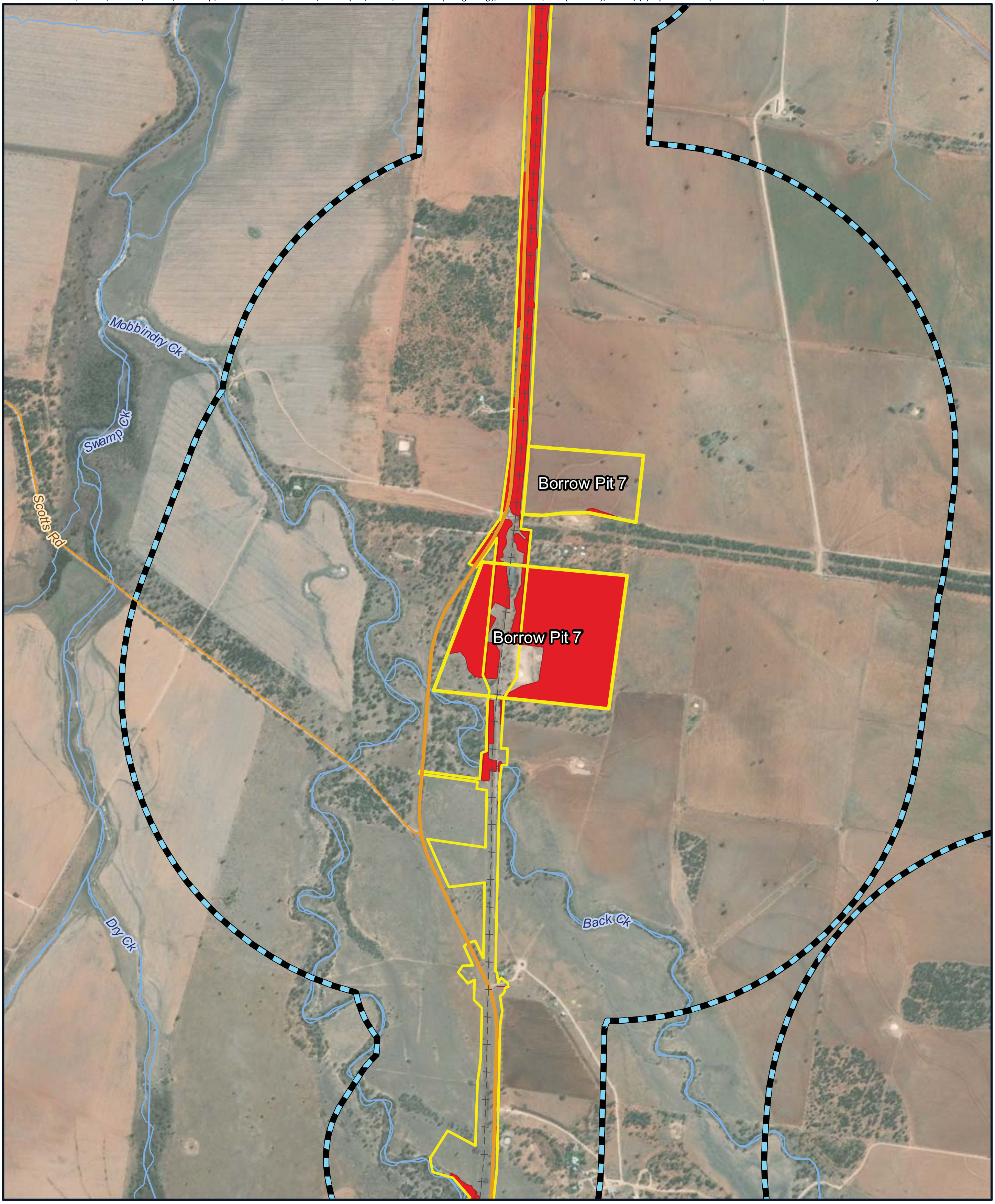
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Koala (*Phascolarctos cinereus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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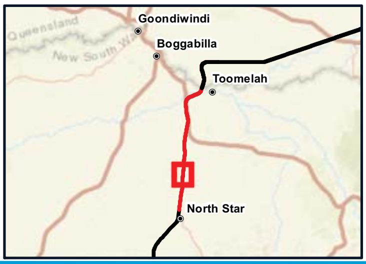
Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

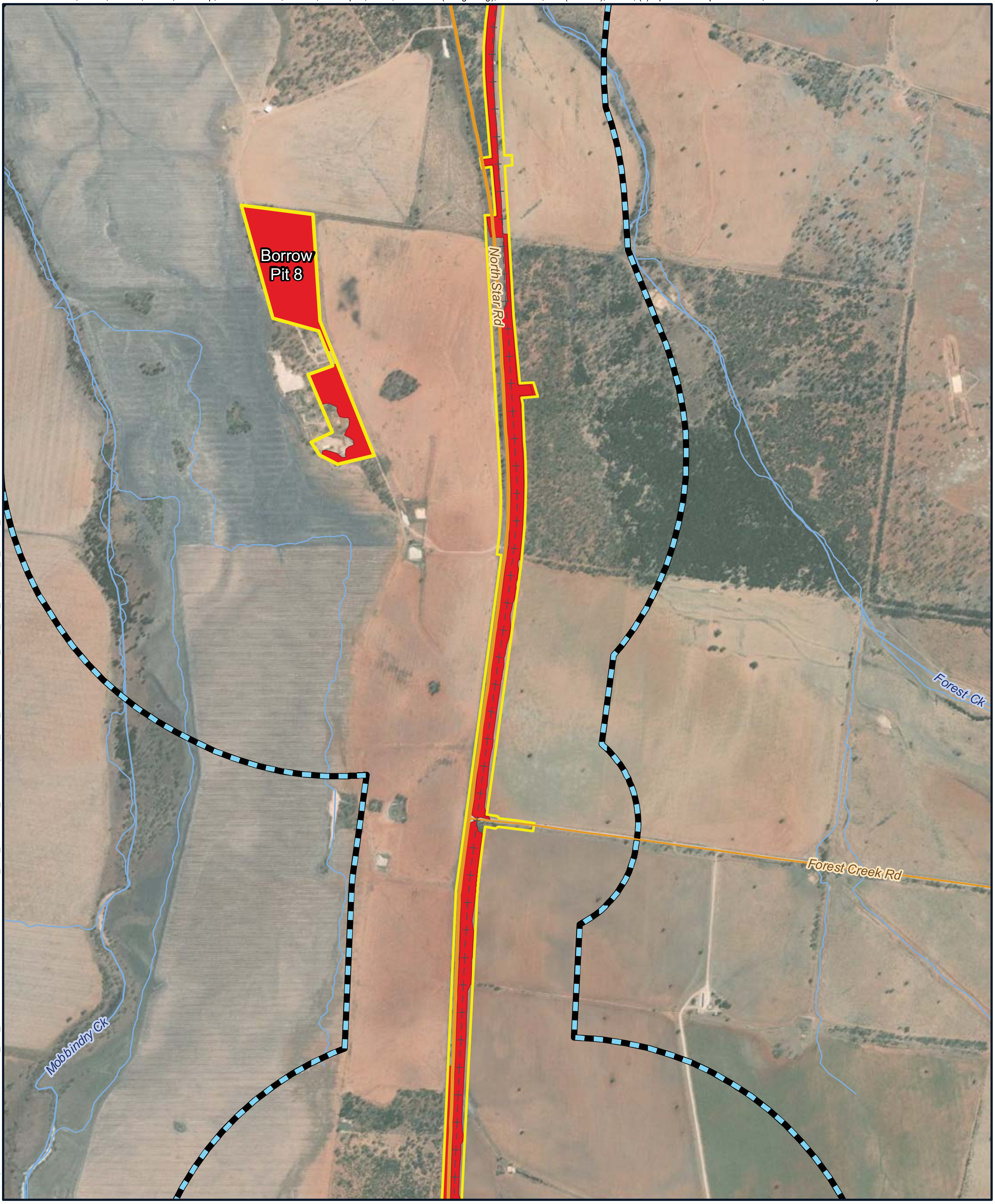
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Koala (*Phascolarctos cinereus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

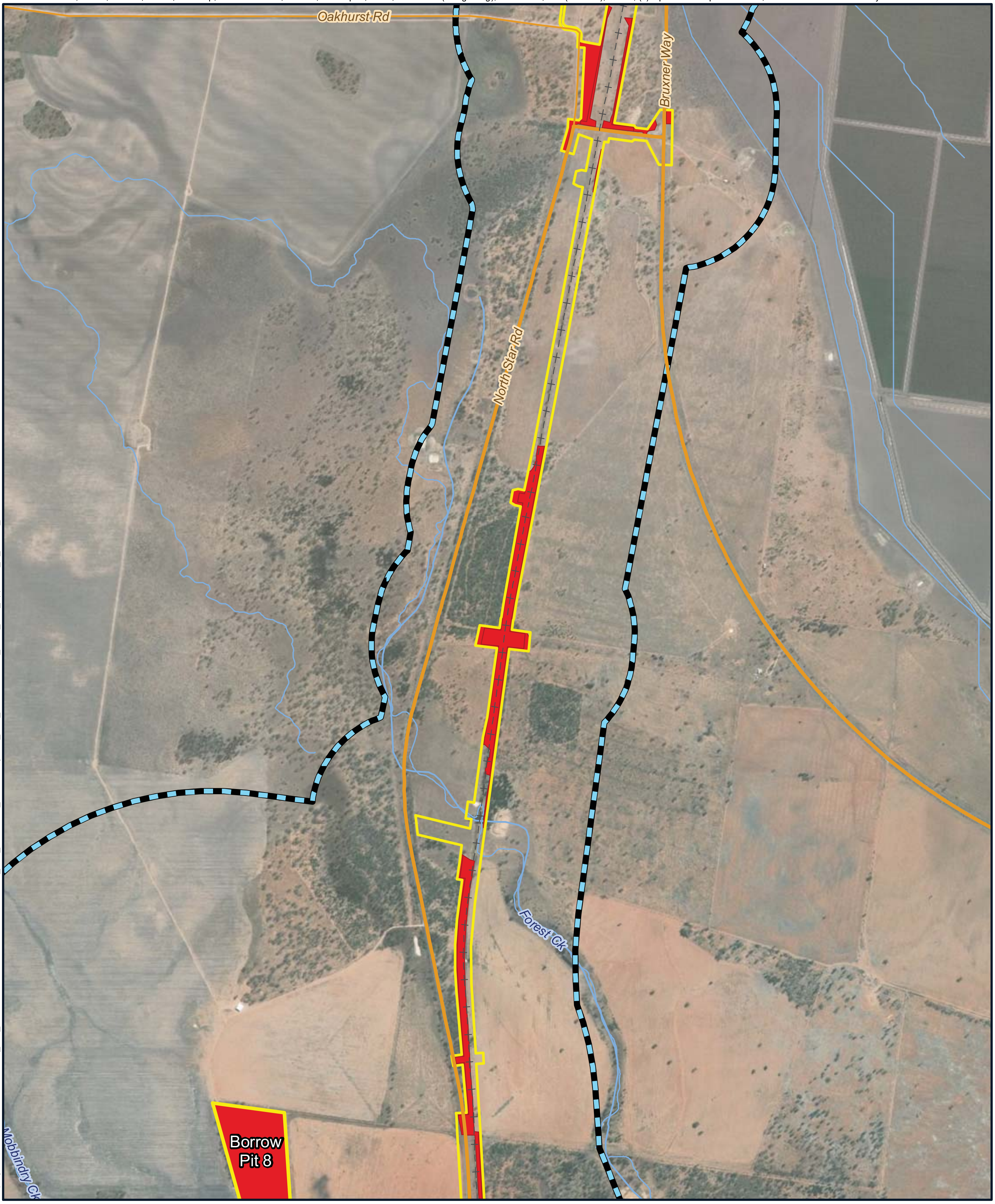
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Koala (*Phascolarctos cinereus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

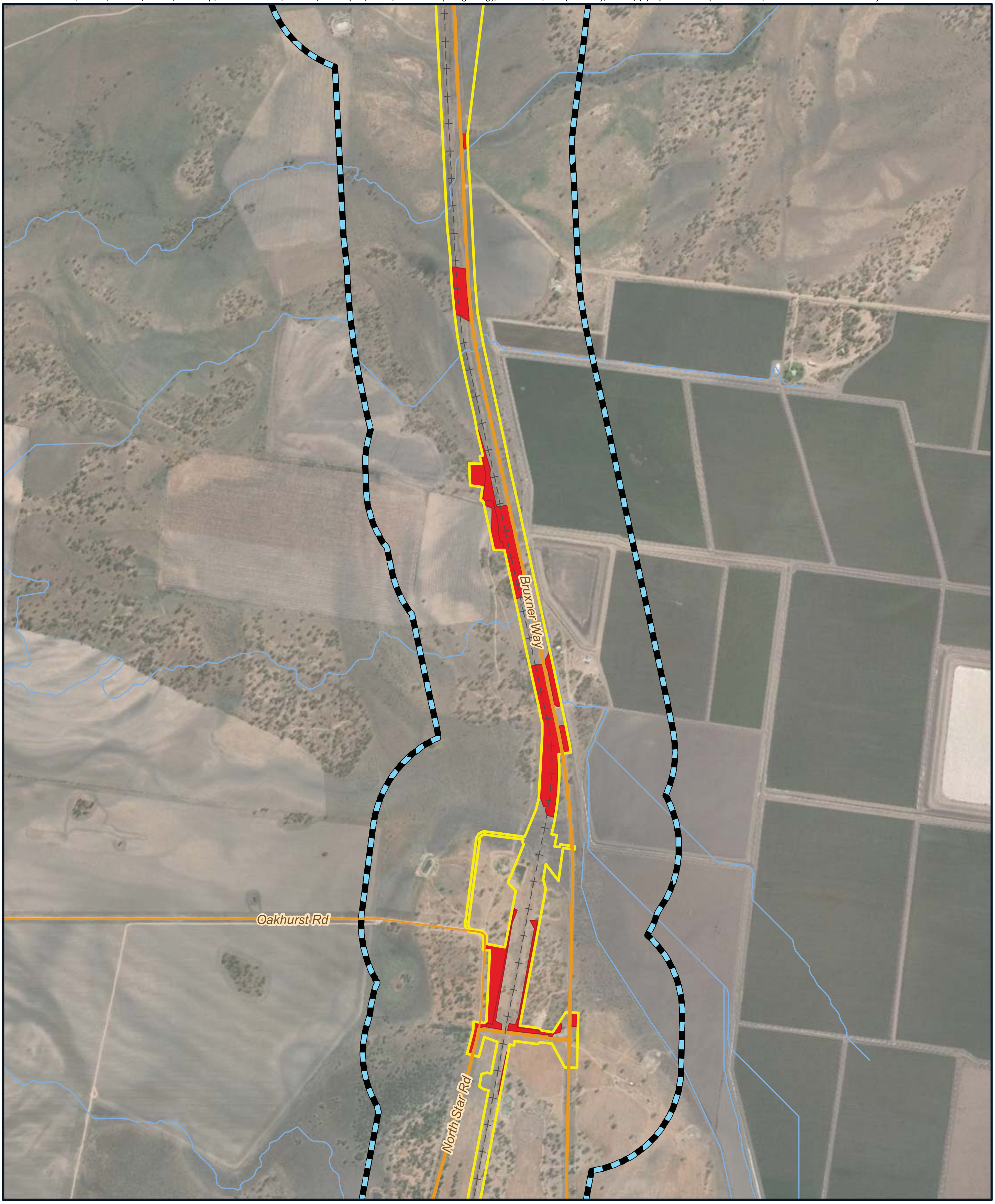
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Koala (*Phascolarctos cinereus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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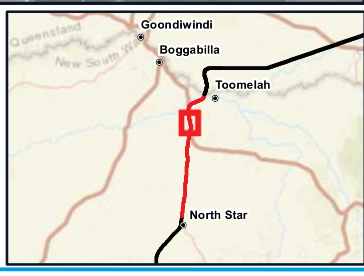
Legend

- Existing rail (non-operational)
- Major roads
- Minor roads
- Study area
- Subject land
- Adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

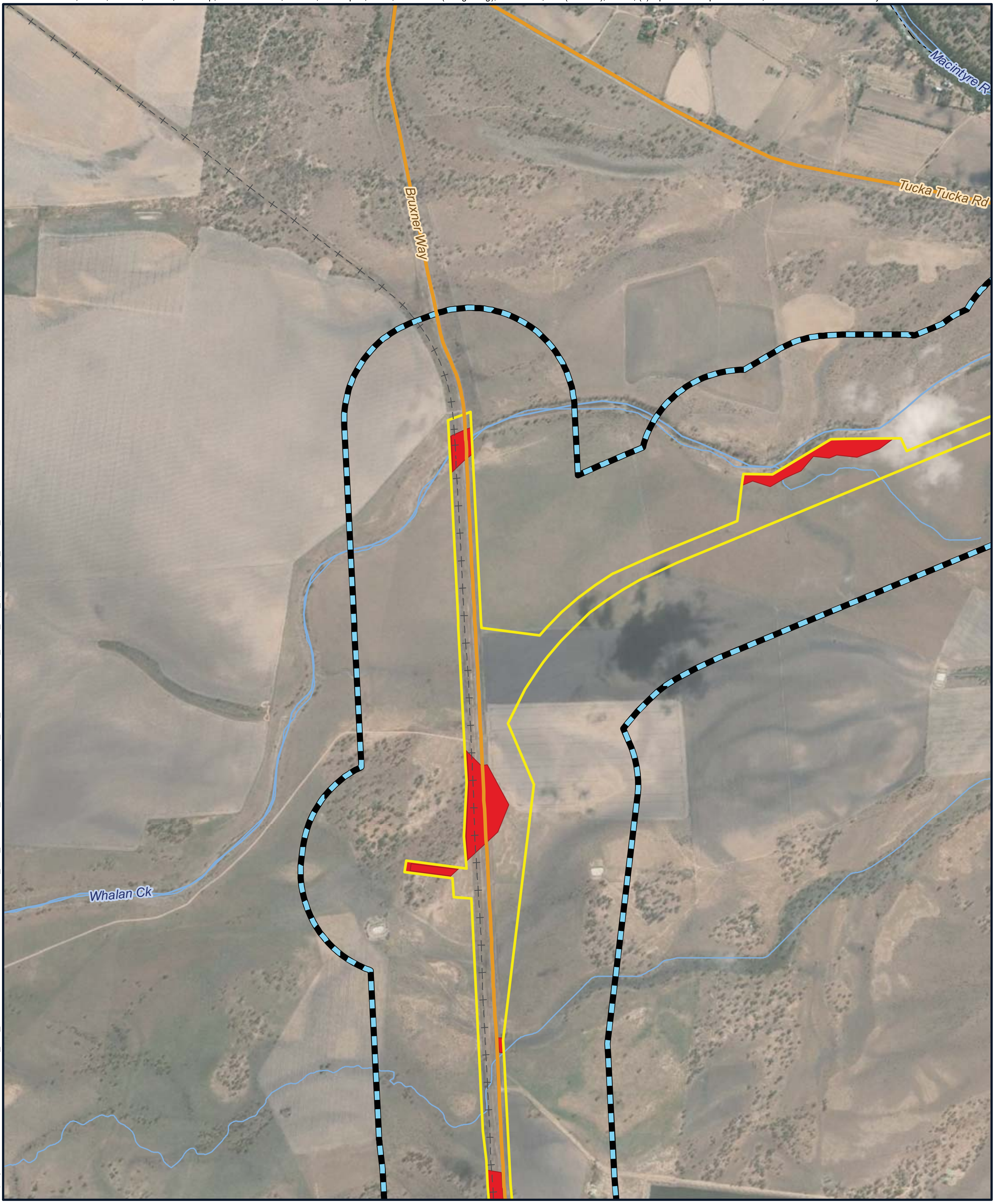
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Koala (*Phascolarctos cinereus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Existing rail (non-operational)
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

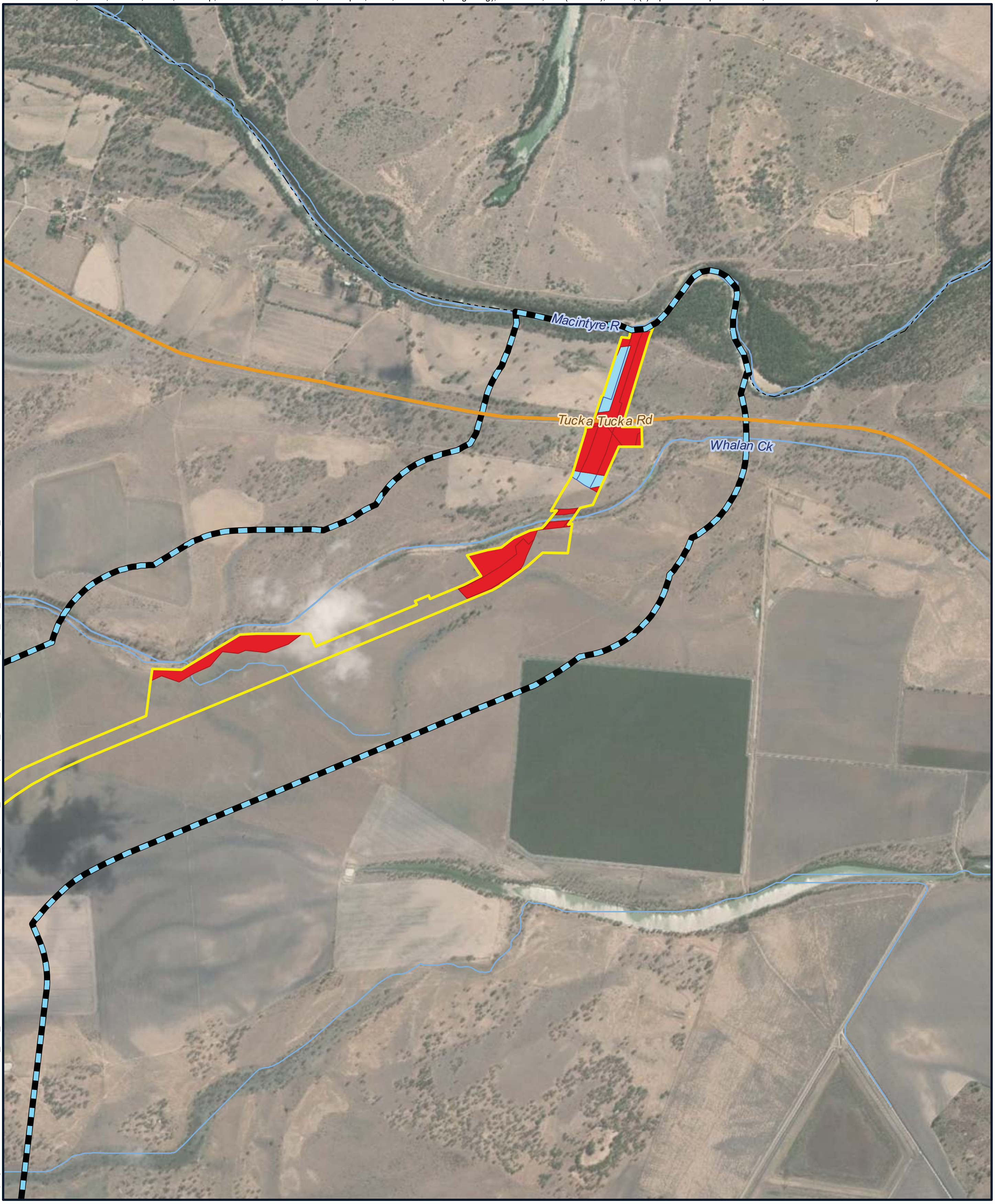
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Koala (*Phascolarctos cinereus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Koala (*Phascolarctos cinereus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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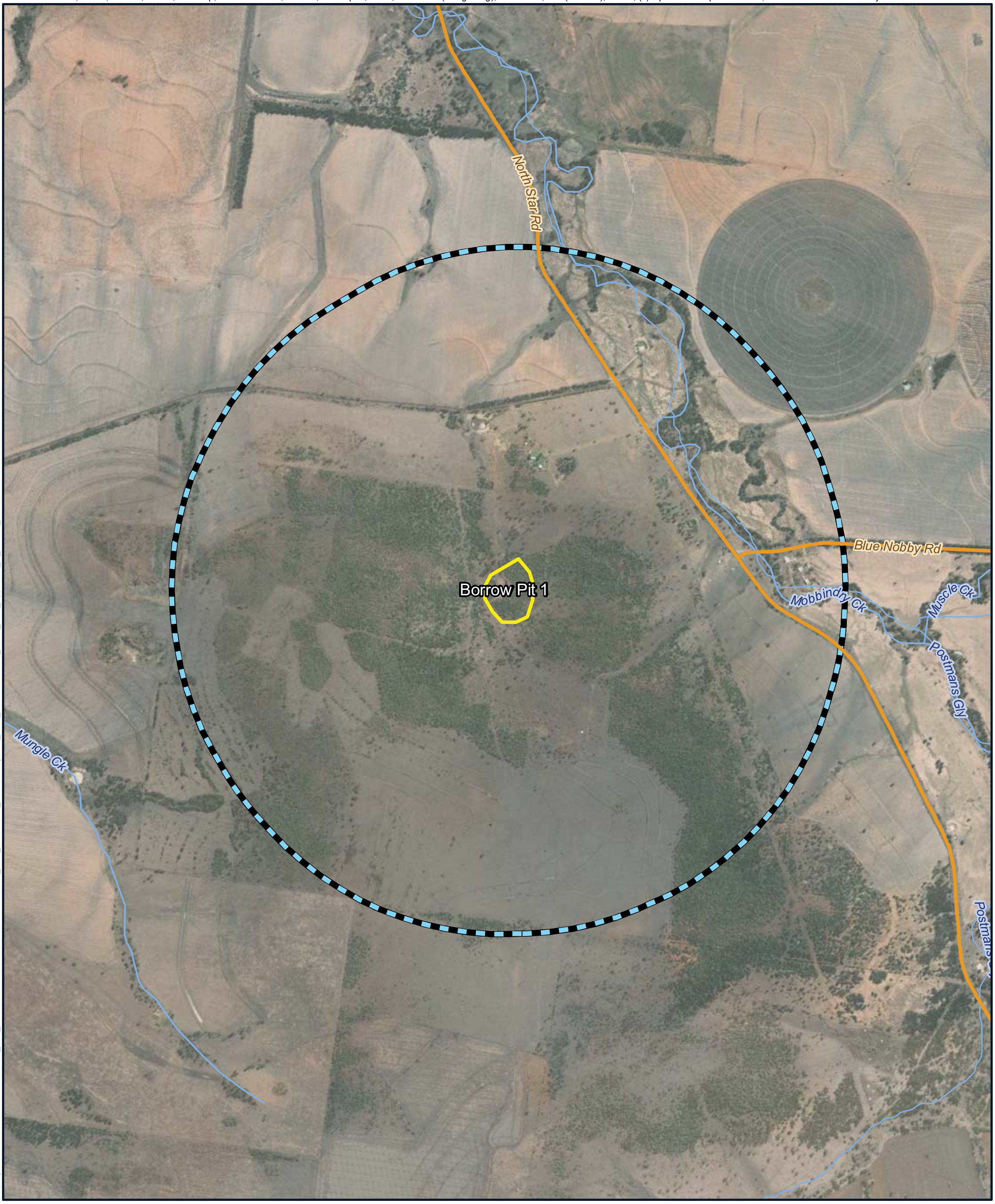
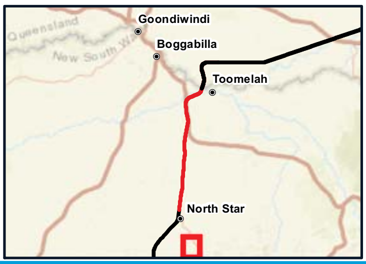


Legend

Subject land
Major roads
Watercourses
Study area
Subject land
Adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Koala (*Phascolarctos cinereus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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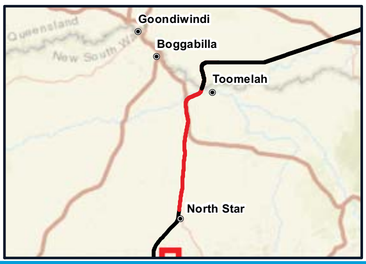
Legend

Subject land
Major roads
Watercourses
Study area
Subject land
Adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Koala (*Phascolarctos cinereus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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Legend

- Subject land
- Minor roads
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

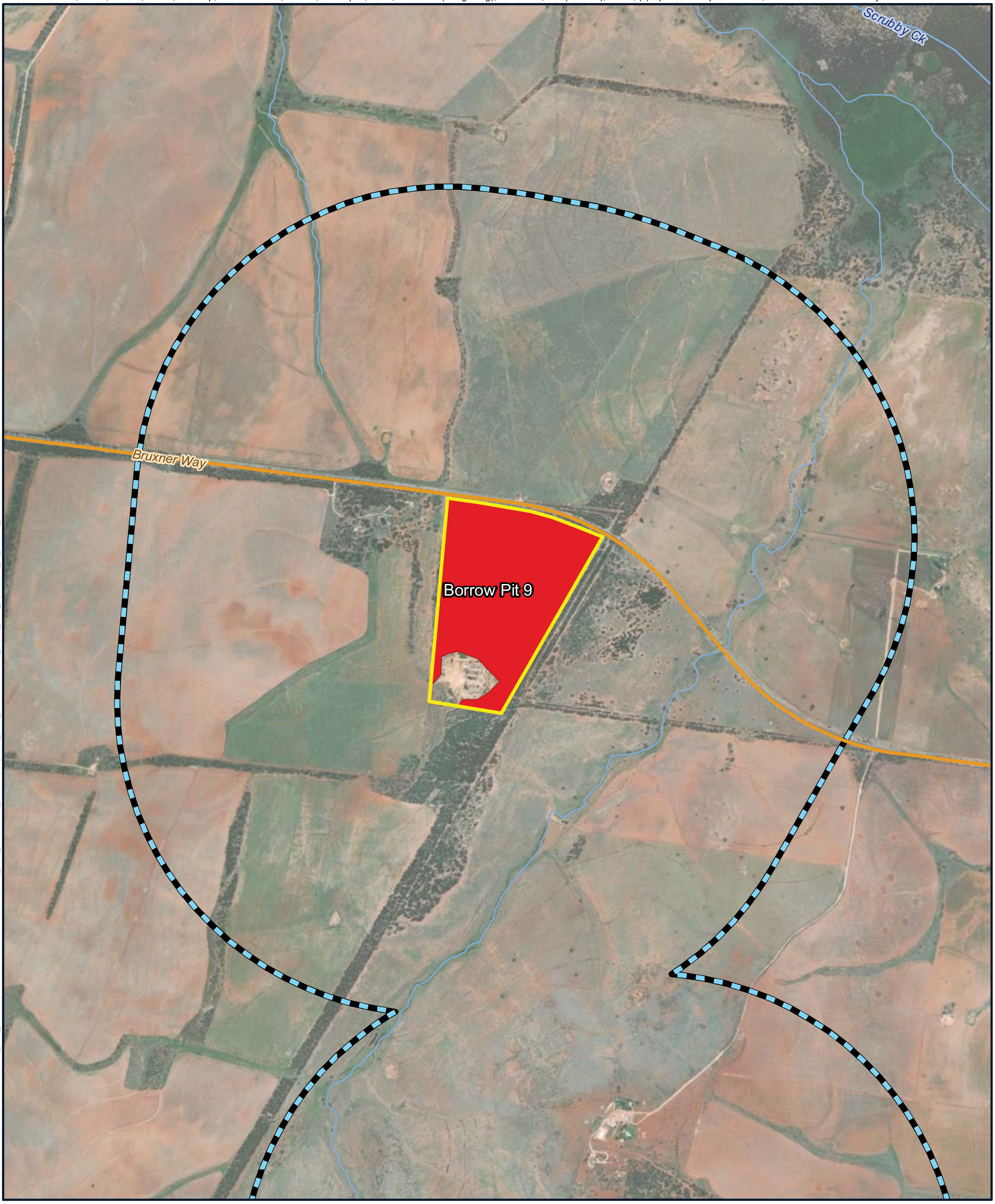
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Koala (*Phascolarctos cinereus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

Subject land
Major roads
Watercourses
Study area
Subject land
Adversely impacted habitat

A4 scale: 1:25,000
0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Koala (*Phascolarctos cinereus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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Legend

- Subject land
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Koala (*Phascolarctos cinereus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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Legend

Subject land
Major roads
Minor roads
Watercourses
Study area
Subject land
Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Koala (*Phascolarctos cinereus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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Legend

Subject land
Minor roads
Watercourses
Study area
Subject land
Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Koala (*Phascolarctos cinereus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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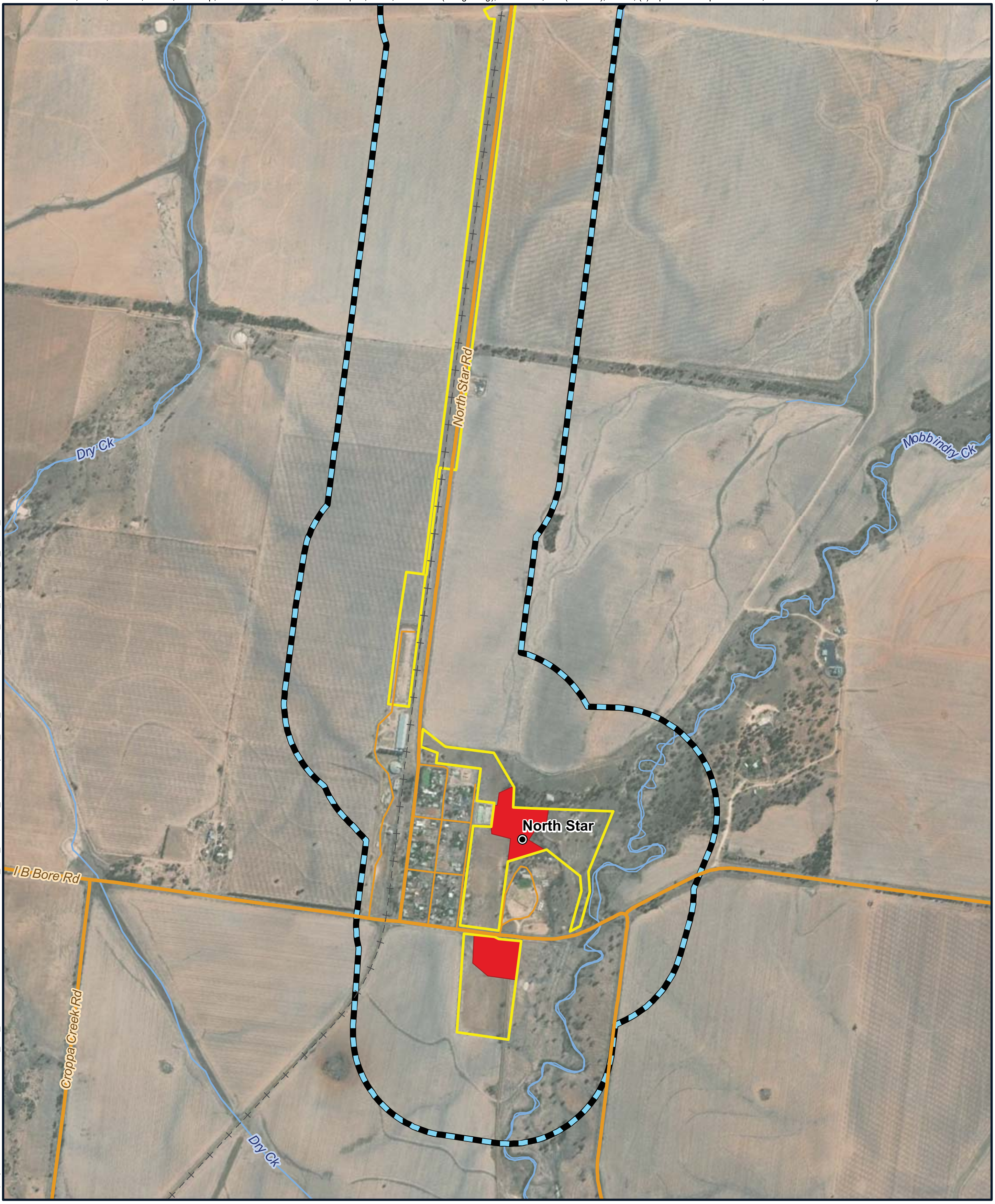

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Legend

- Localities
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Grey-headed flying-fox (*Pteropus poliocephalus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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Legend

- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

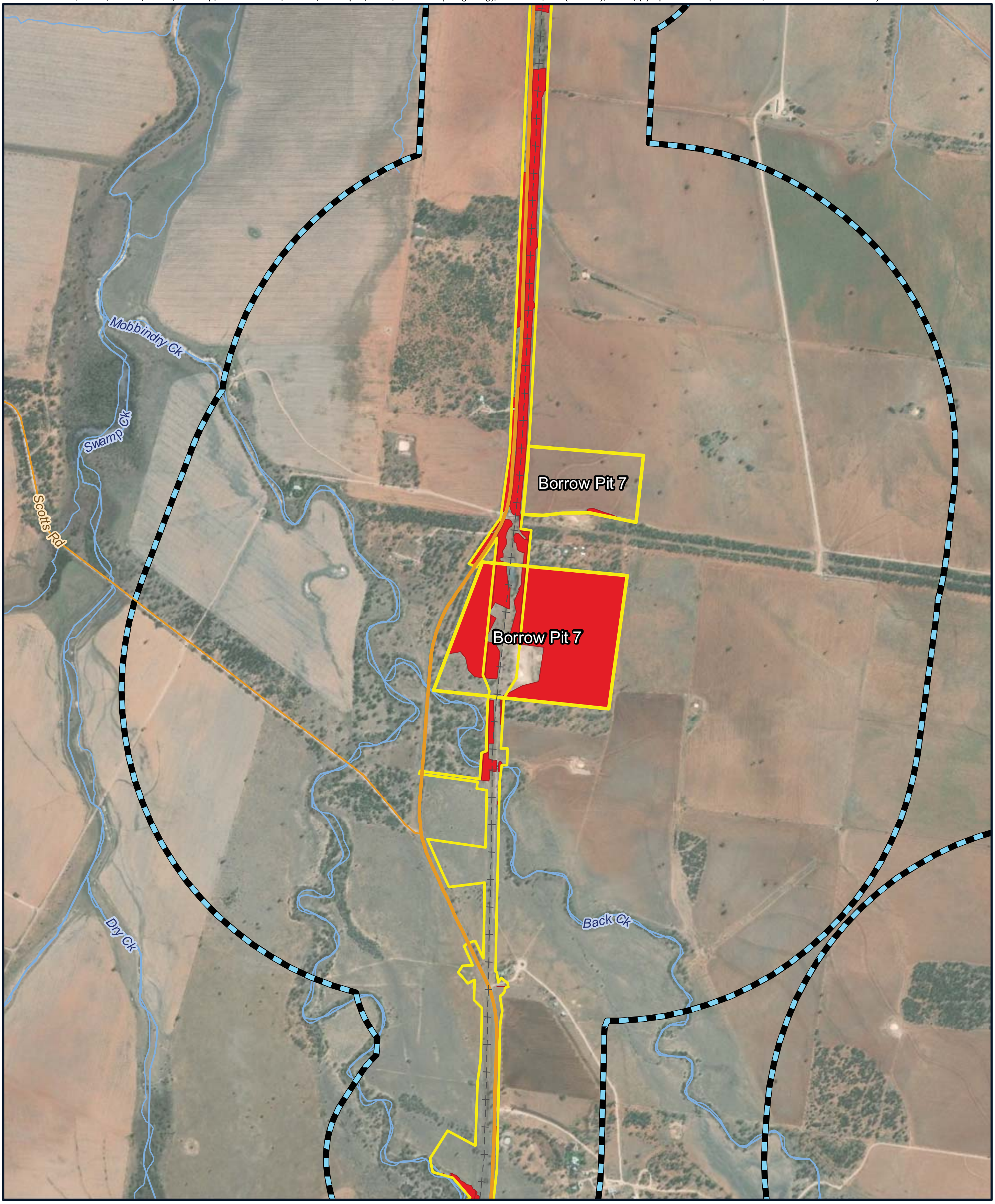
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Grey-headed flying-fox (*Pteropus poliocephalus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

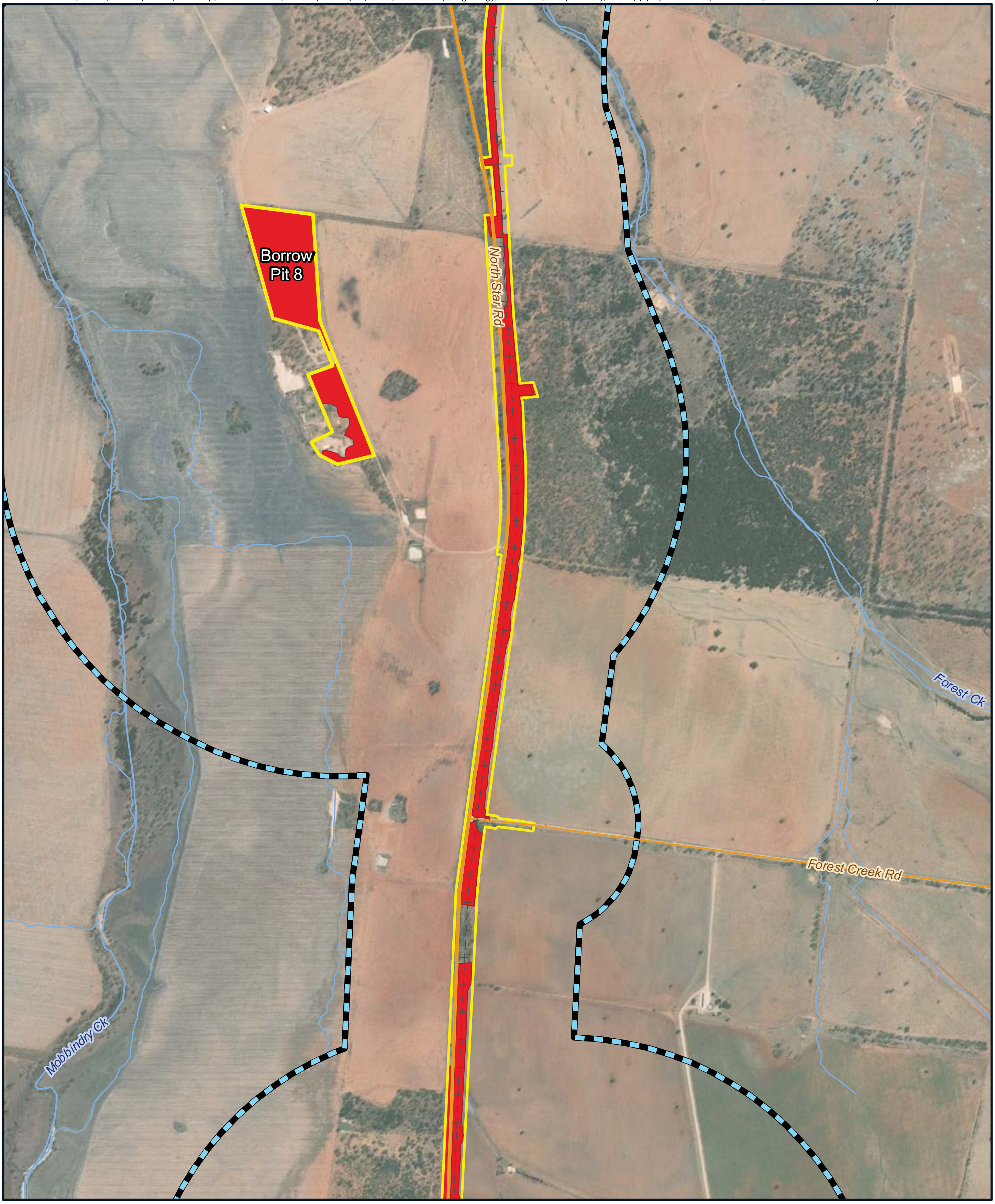
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Grey-headed flying-fox (*Pteropus poliocephalus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight

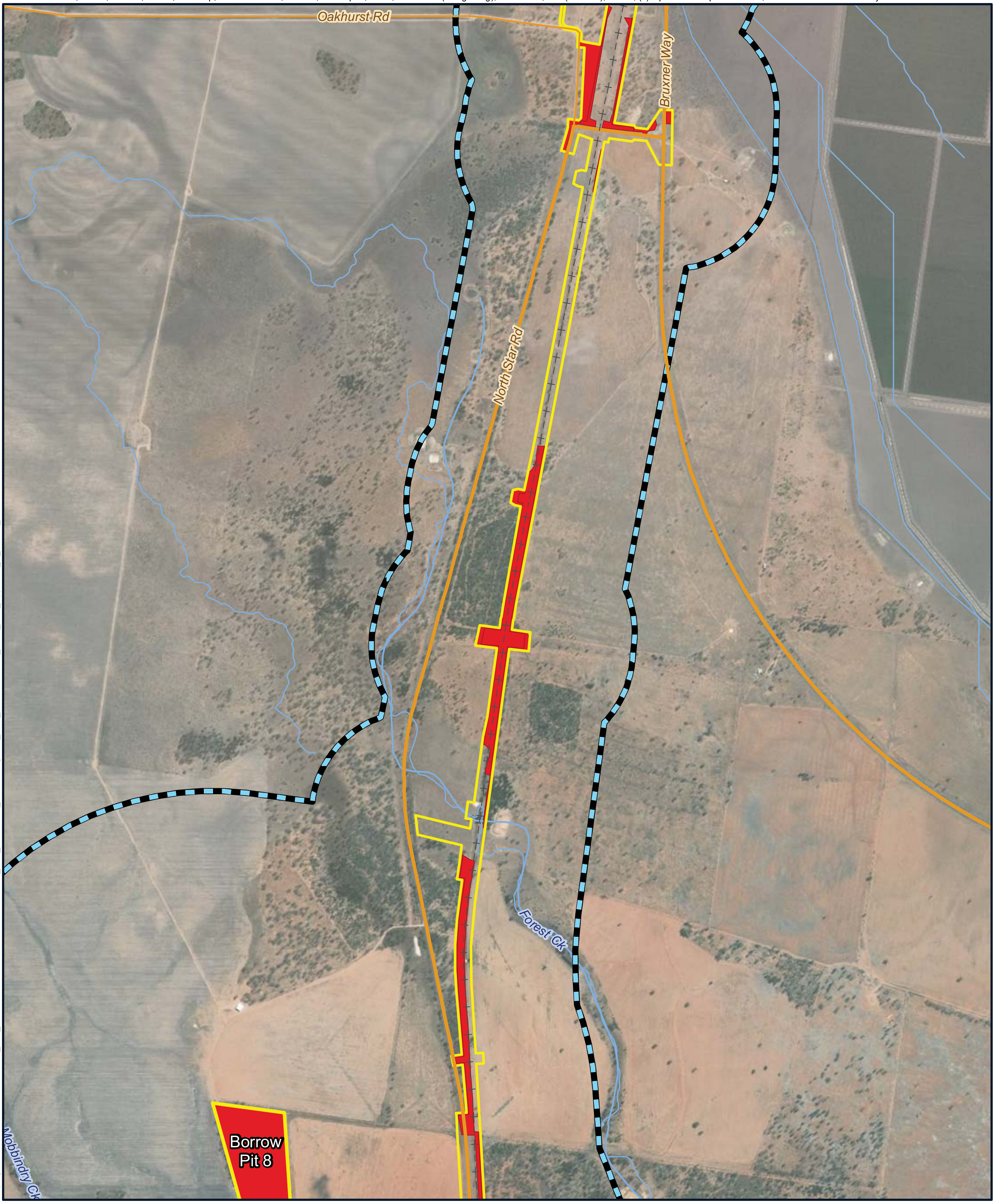
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Grey-headed flying-fox (*Pteropus poliocephalus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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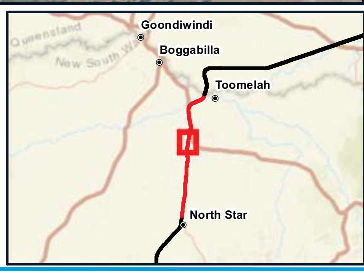
Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Grey-headed flying-fox (*Pteropus poliocephalus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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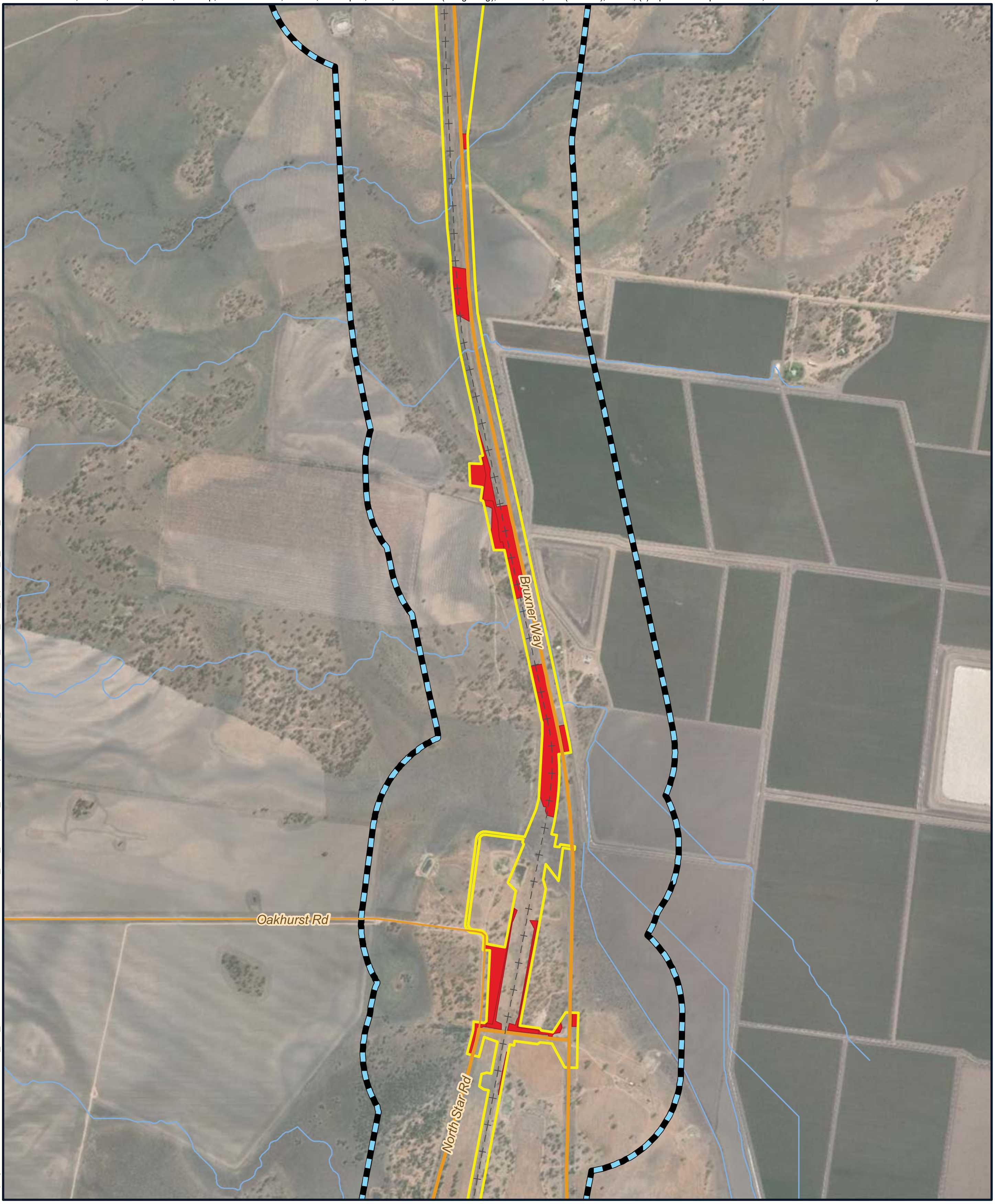
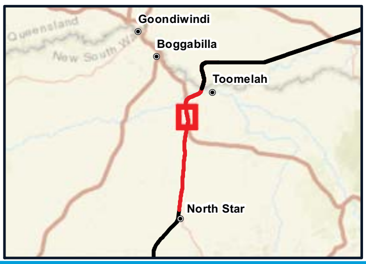


Legend

- Existing rail (non-operational)
- Major roads
- Minor roads
- Study area
- Subject land
- Adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

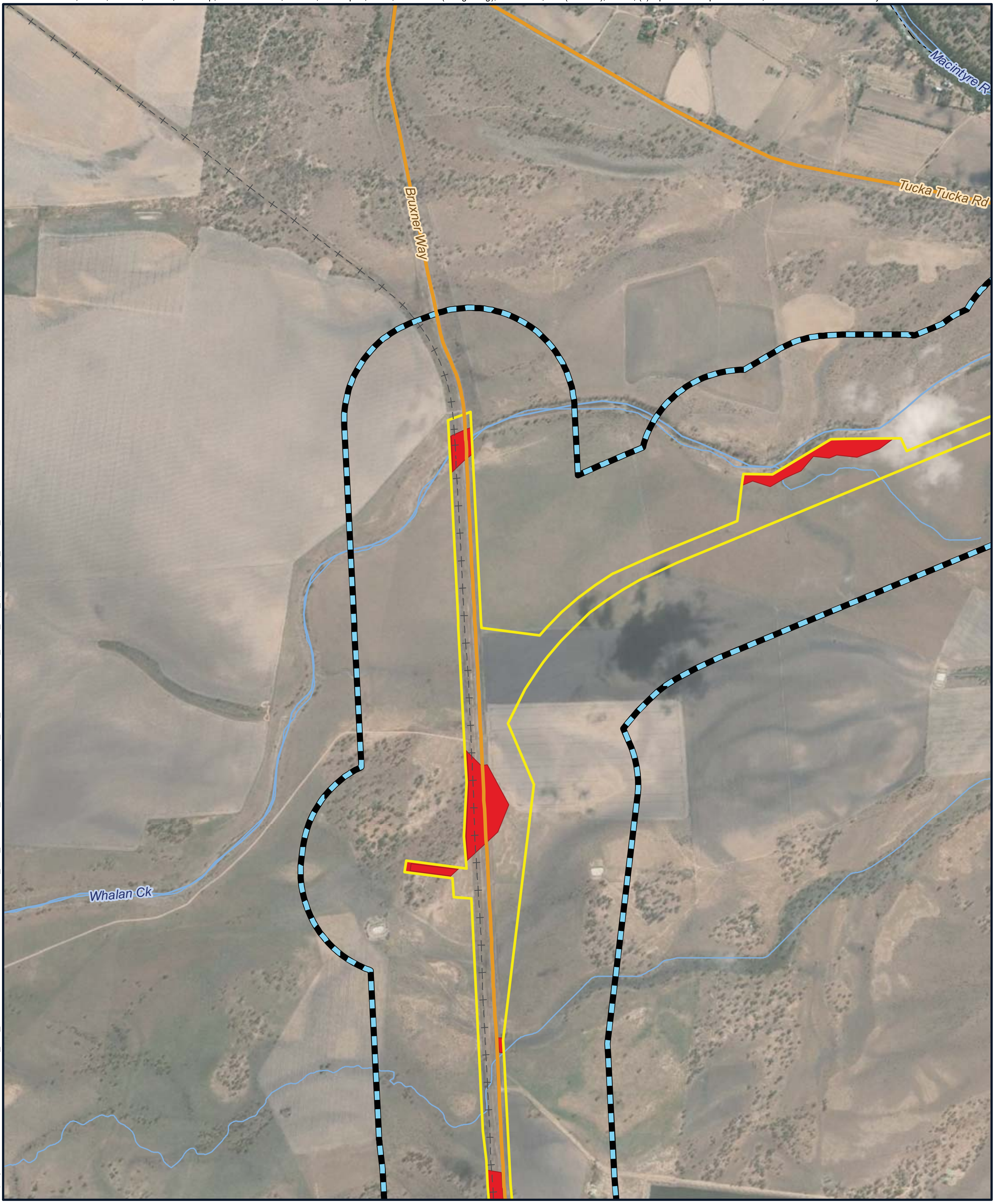
Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Grey-headed flying-fox (*Pteropus poliocephalus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

- Existing rail (non-operational)
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Grey-headed flying-fox (*Pteropus poliocephalus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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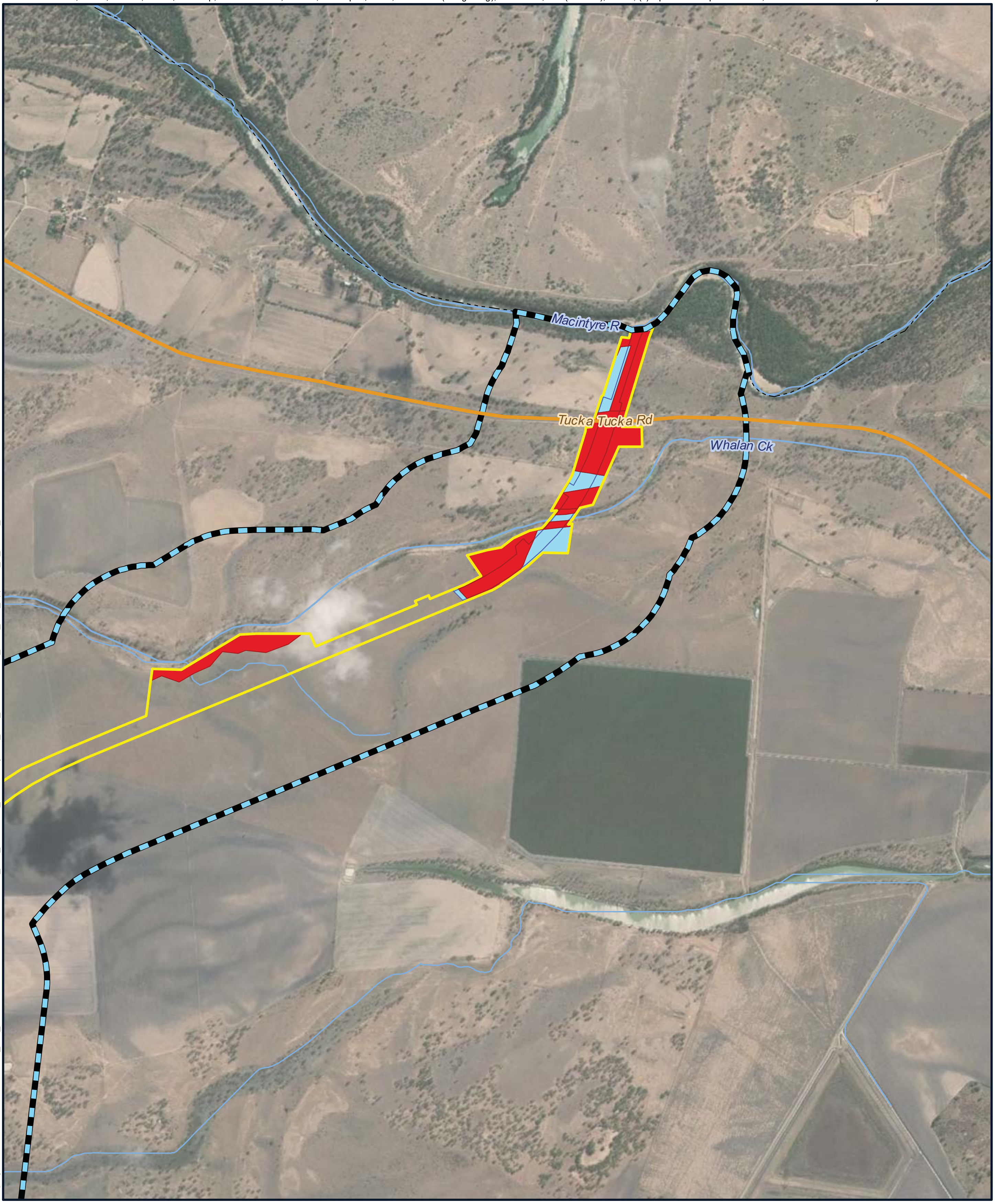

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Legend

- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Grey-headed flying-fox (*Pteropus poliocephalus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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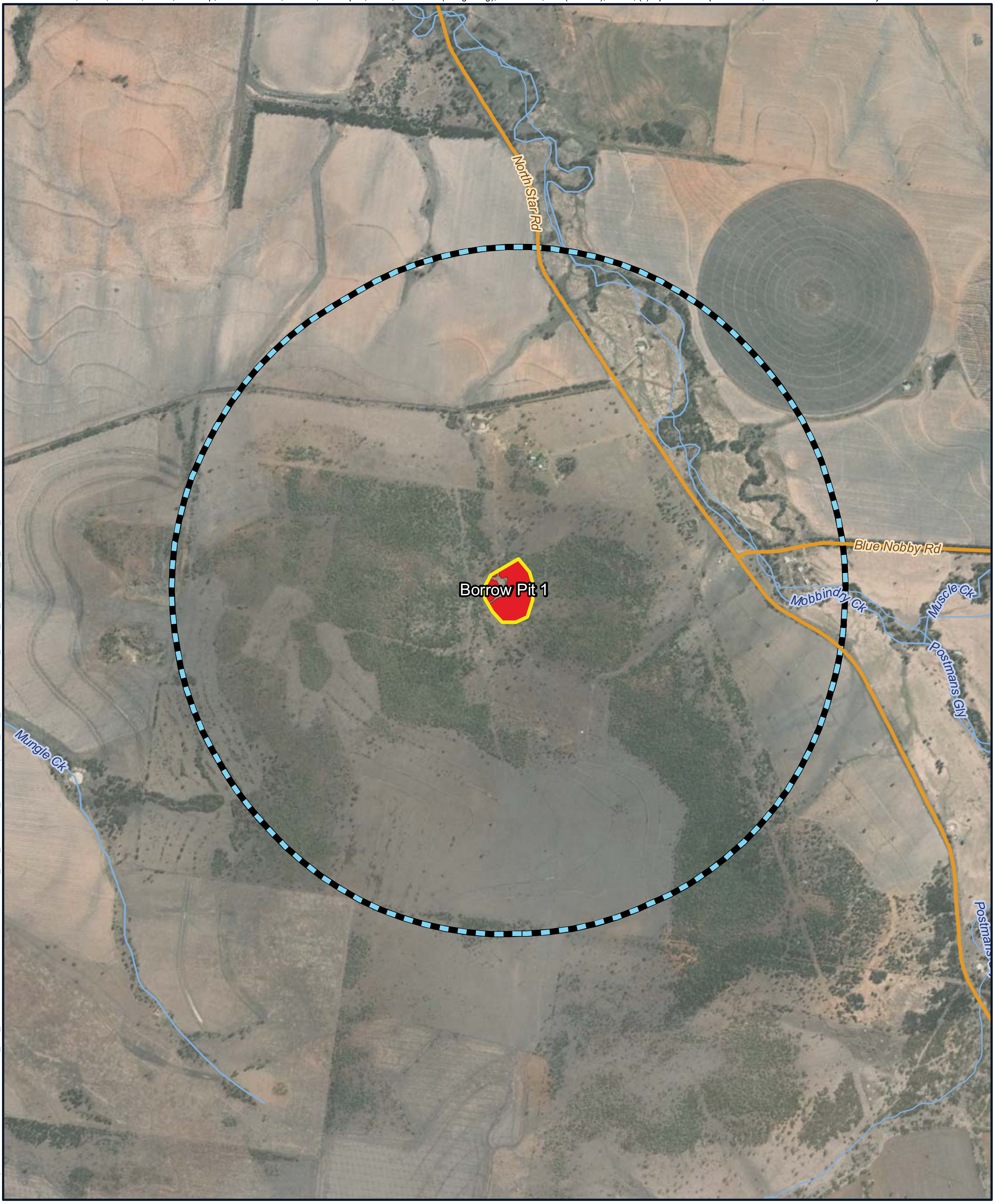

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Legend

- Subject land
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Grey-headed flying-fox (*Pteropus poliocephalus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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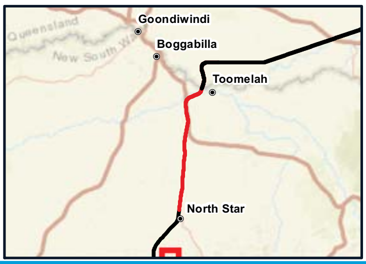
Legend

- Subject land
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Grey-headed flying-fox (*Pteropus poliocephalus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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Legend

- Subject land
- Minor roads
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Grey-headed flying-fox (*Pteropus poliocephalus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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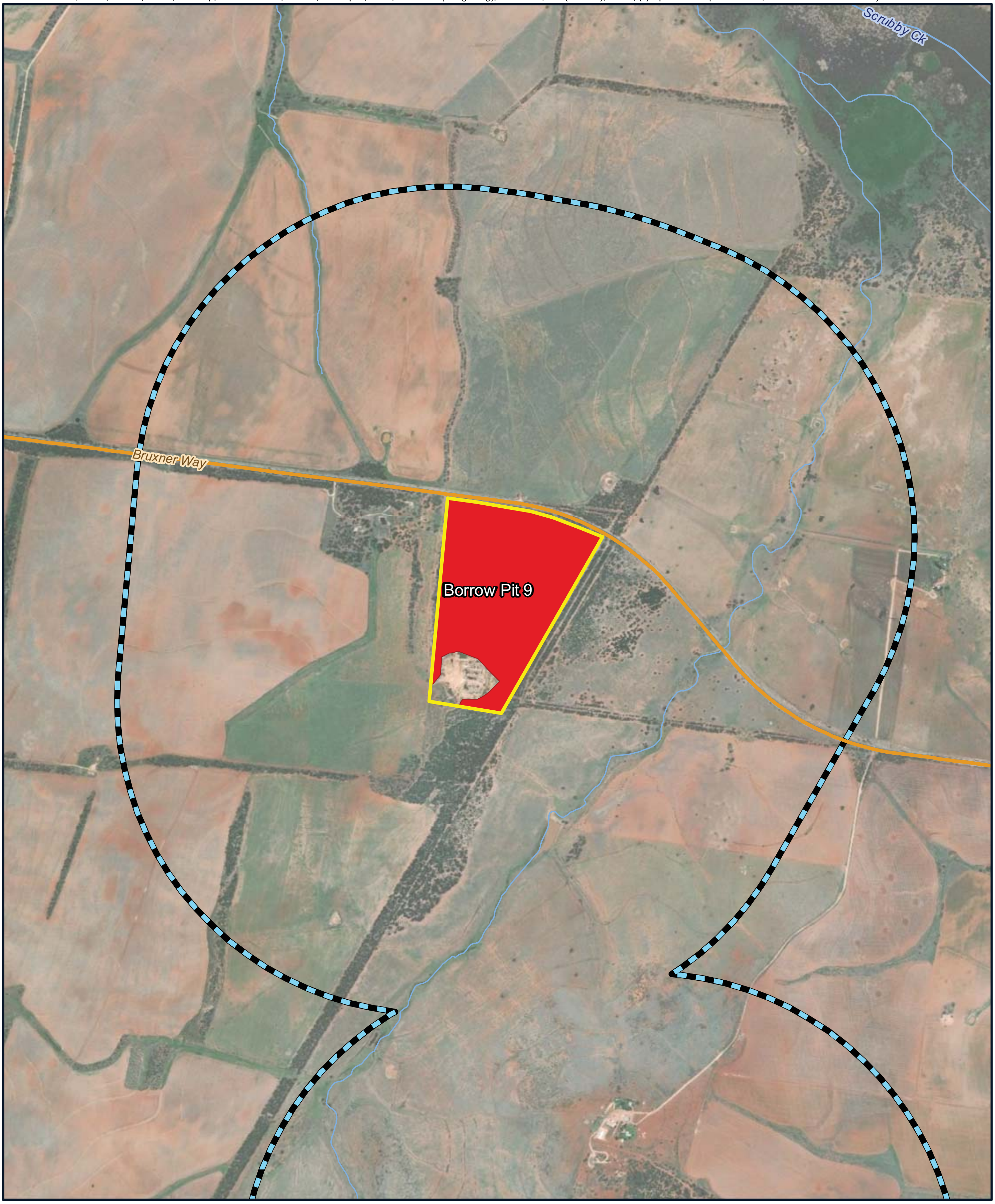

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Legend

Subject land
Major roads
Watercourses
Study area
Subject land
Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Grey-headed flying-fox (*Pteropus poliocephalus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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Legend

Subject land
Major roads
Minor roads
Watercourses
Study area
Subject land
Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Grey-headed flying-fox (*Pteropus poliocephalus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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Legend

- Subject land
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Grey-headed flying-fox (*Pteropus poliocephalus*)

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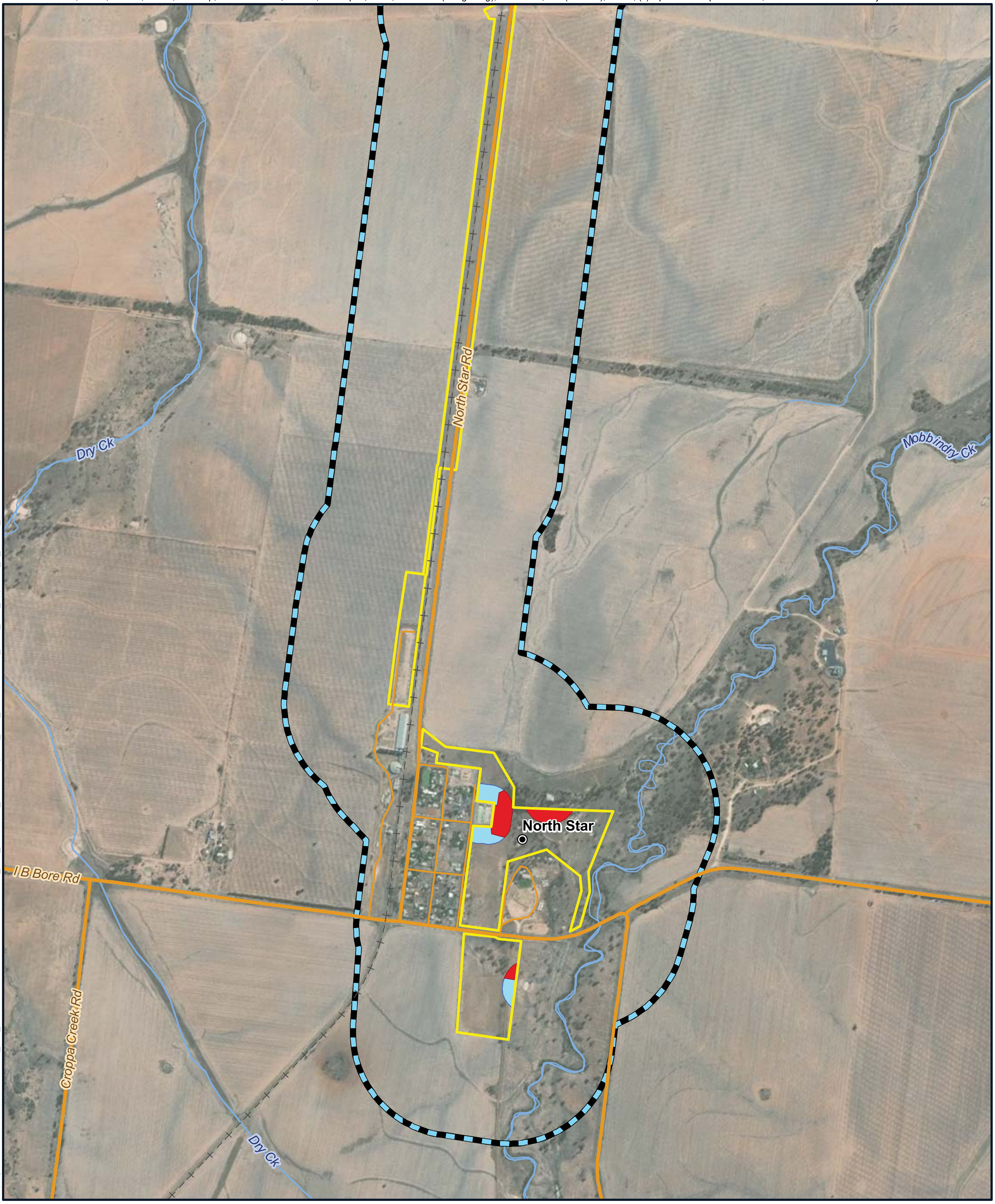

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Legend

- Localities
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Australian painted snipe (*Rostratula australis*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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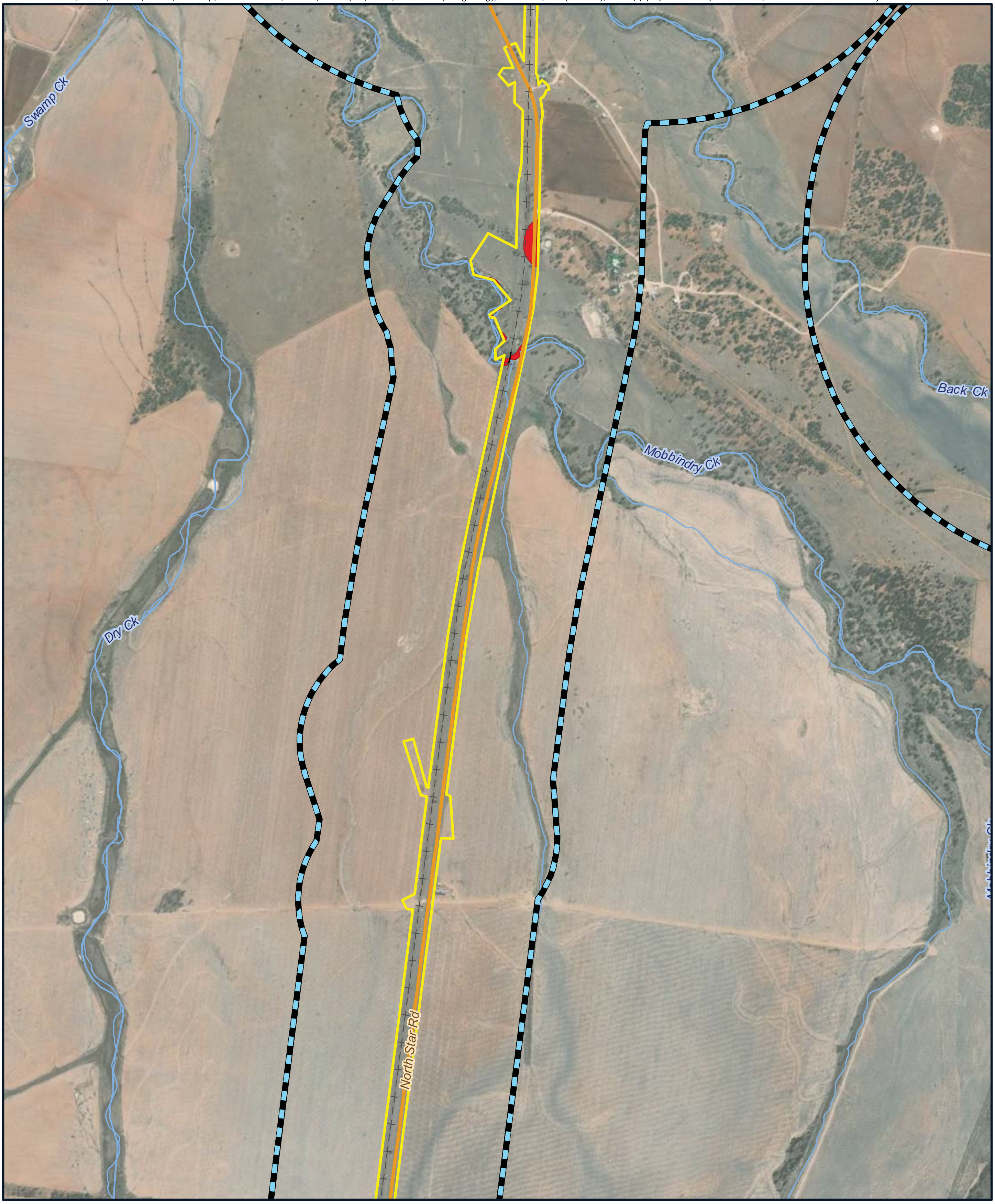

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Legend

- Existing rail (operational)
- Existing rail (non-operational)
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

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Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Australian painted snipe (*Rostratula australis*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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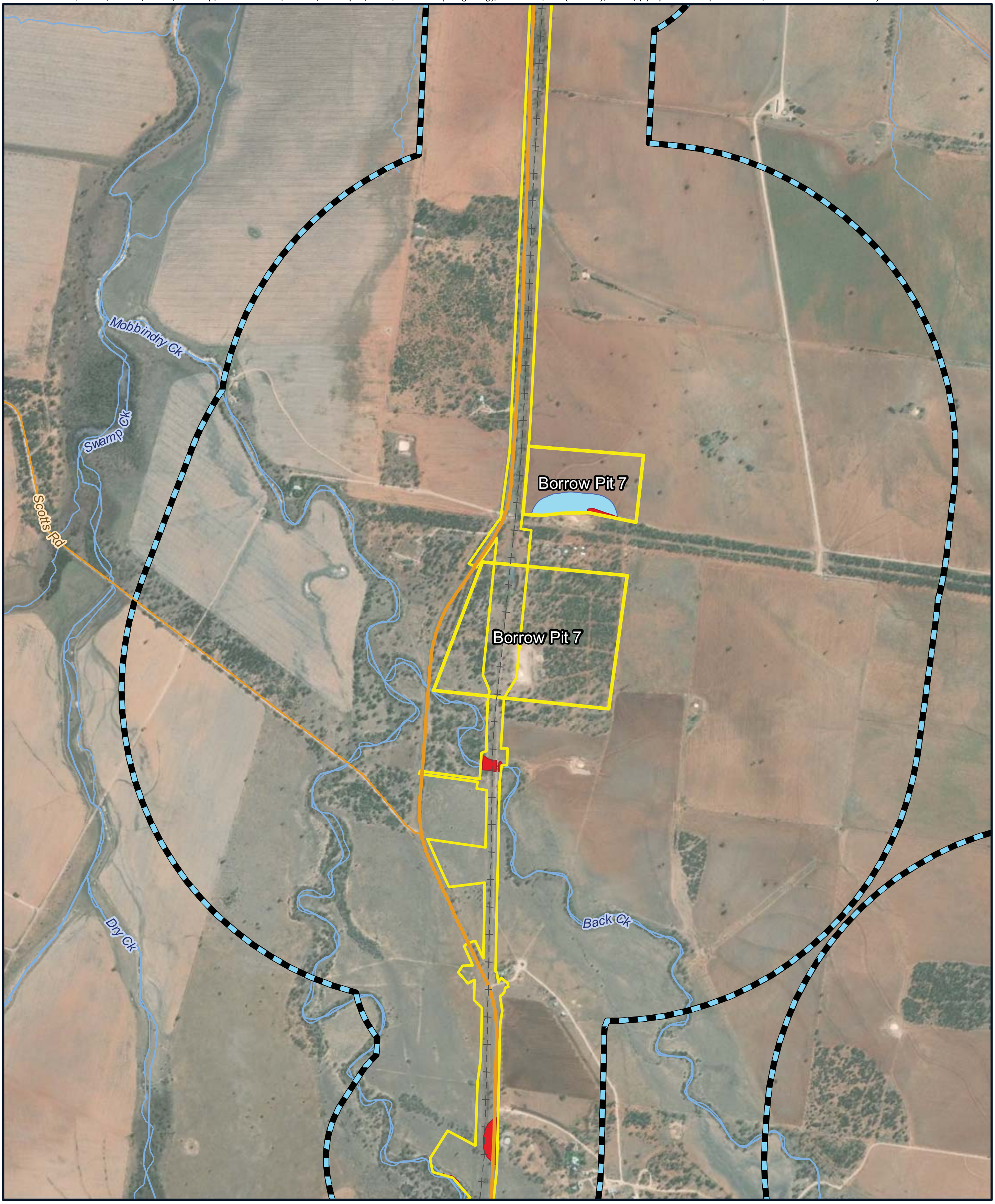

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Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Australian painted snipe (*Rostratula australis*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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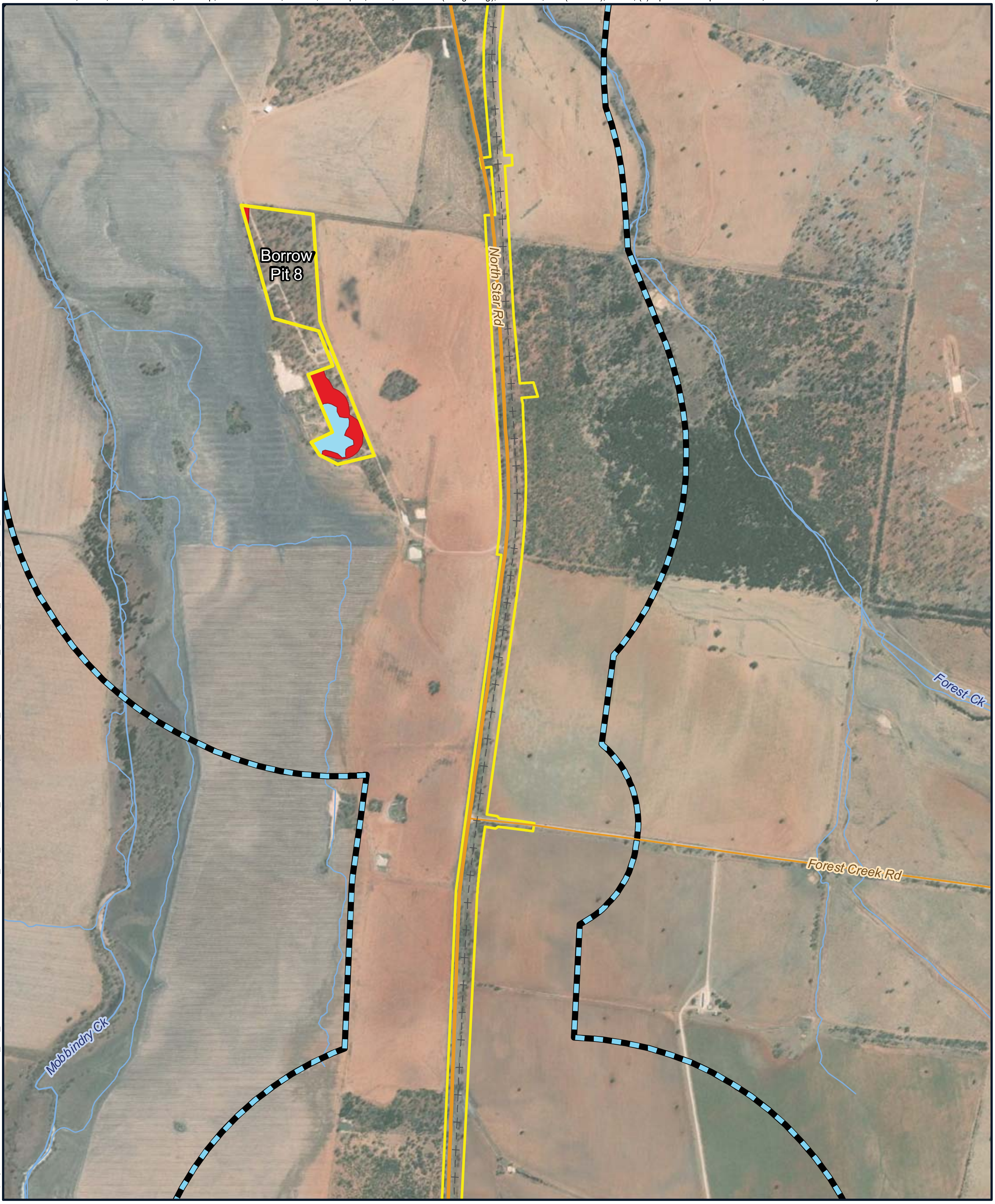

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Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Australian painted snipe (*Rostratula australis*)

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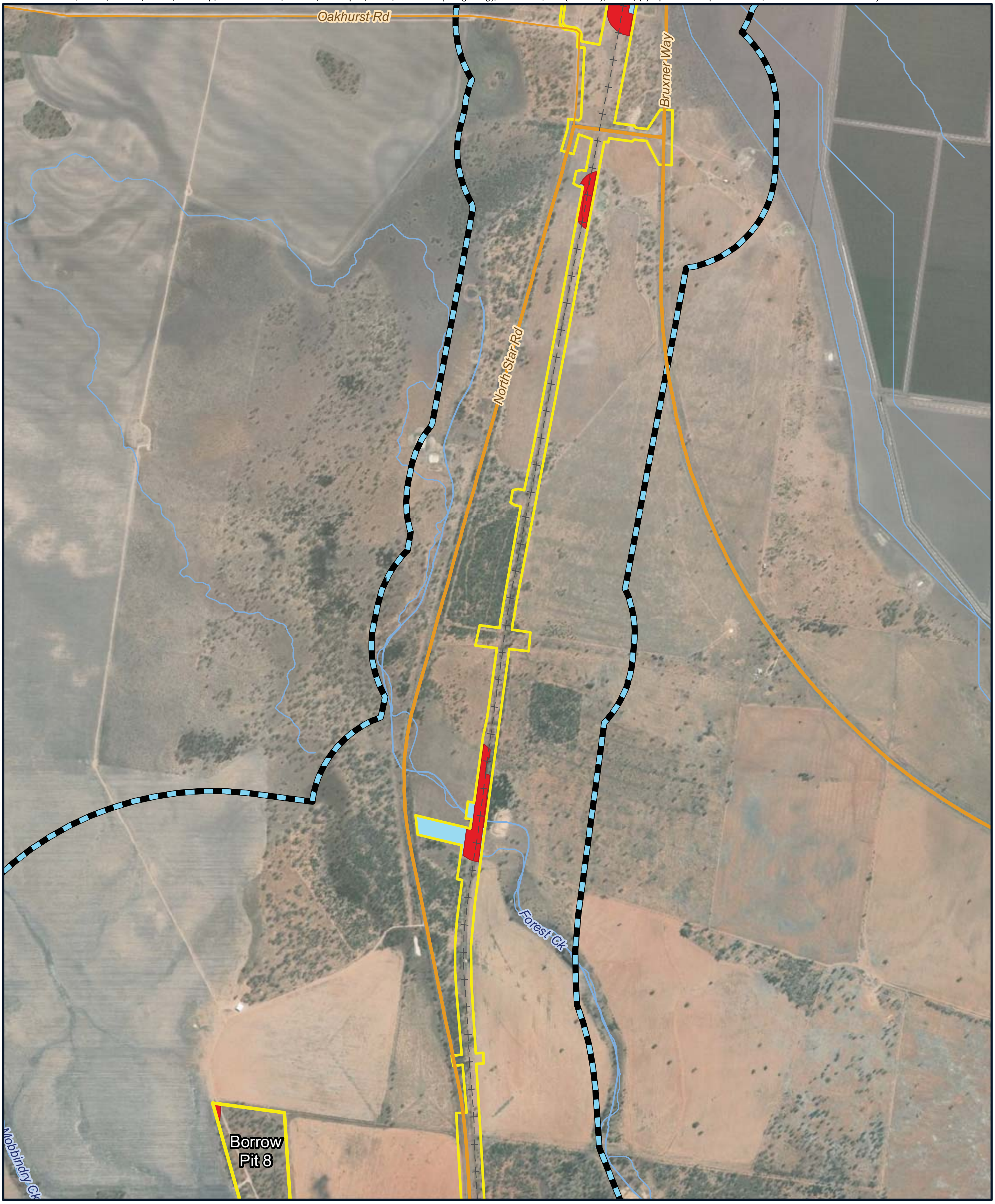

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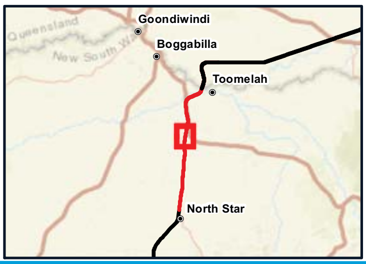
Legend

- Subject land
- Existing rail (non-operational)
- Major roads
- Minor roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

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Australian painted snipe (*Rostratula australis*)

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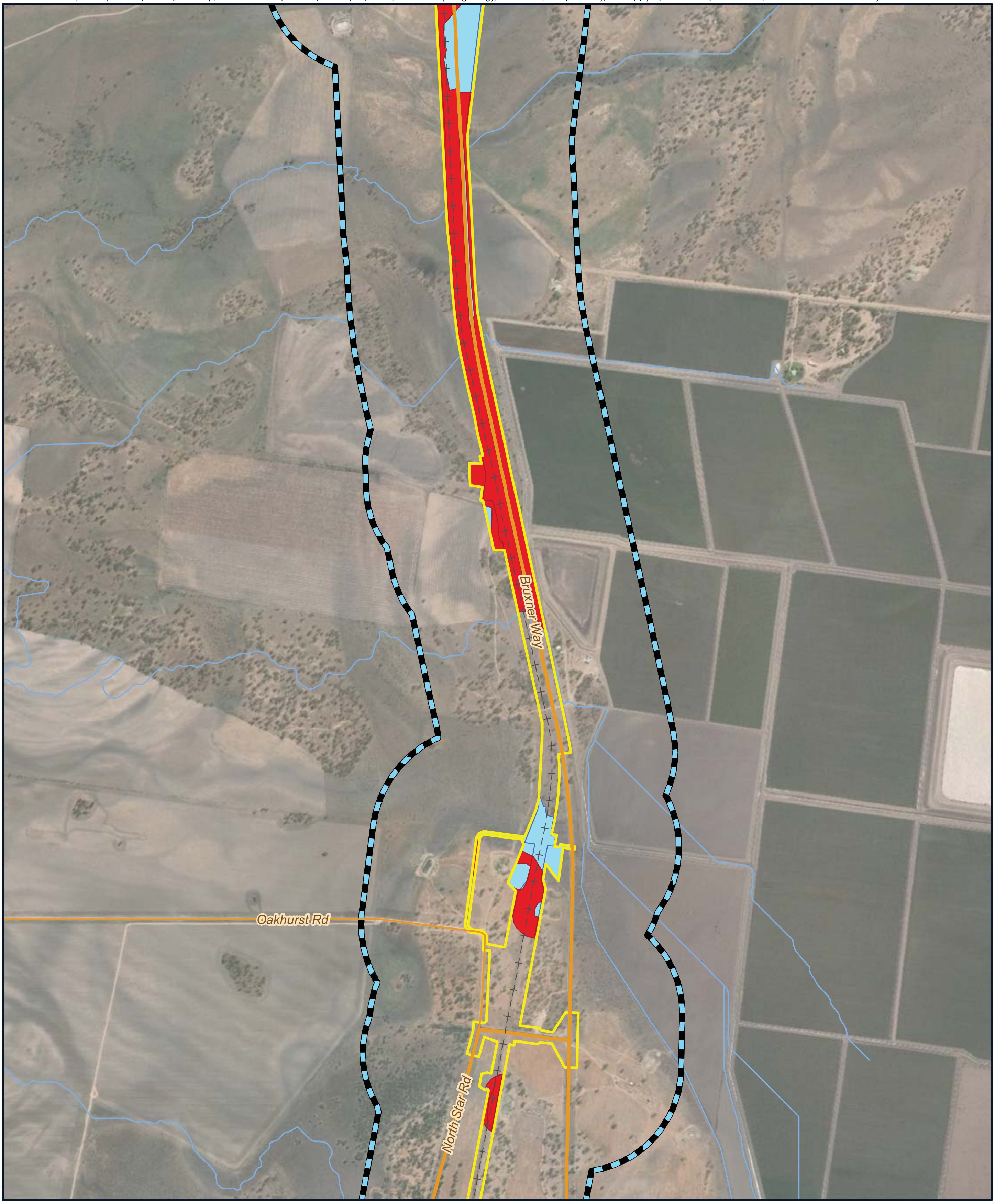

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Legend

- Existing rail (non-operational)
- Major roads
- Minor roads
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Australian painted snipe (*Rostratula australis*)

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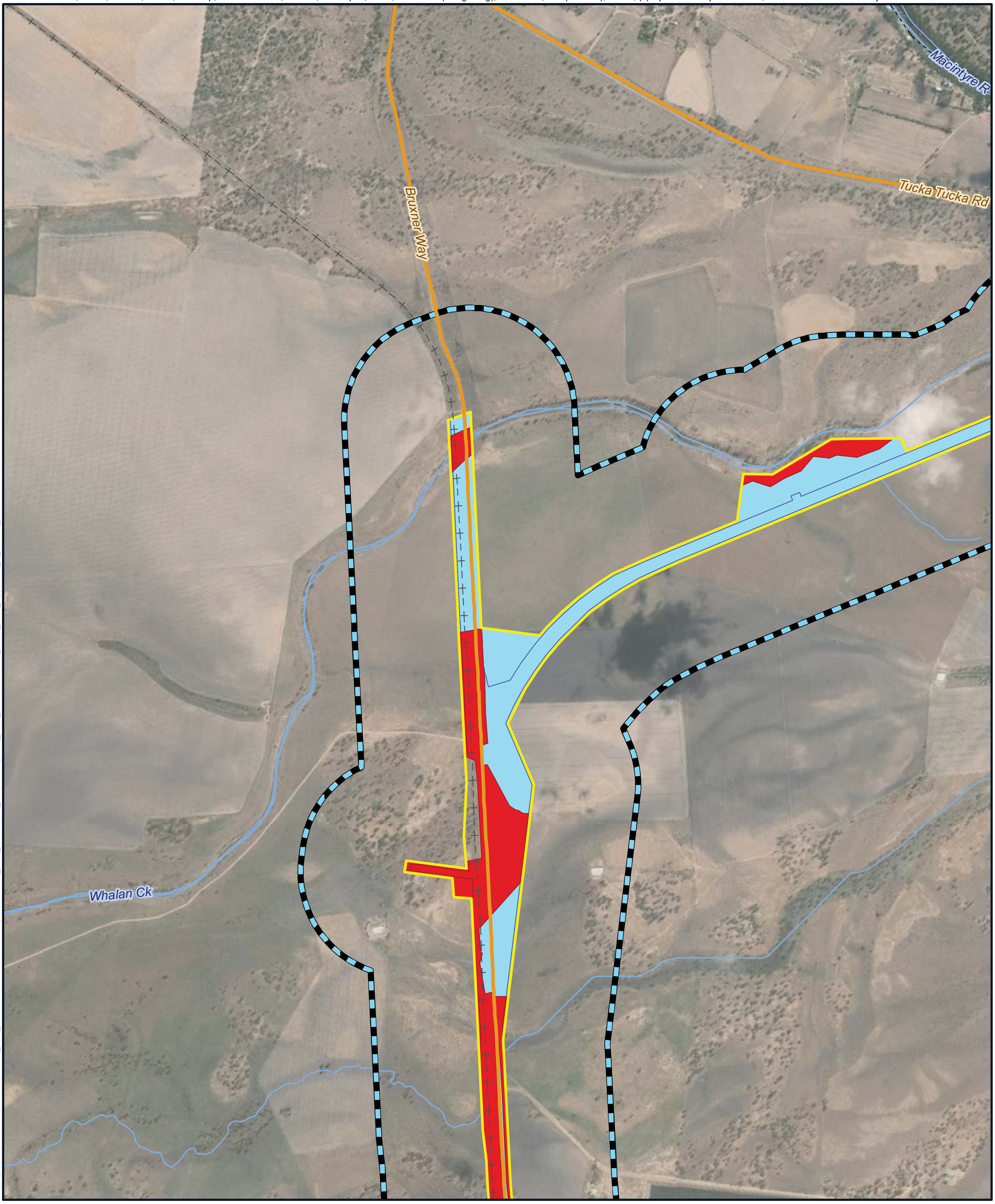

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Legend

- Existing rail (non-operational)
- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

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Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Australian painted snipe (*Rostratula australis*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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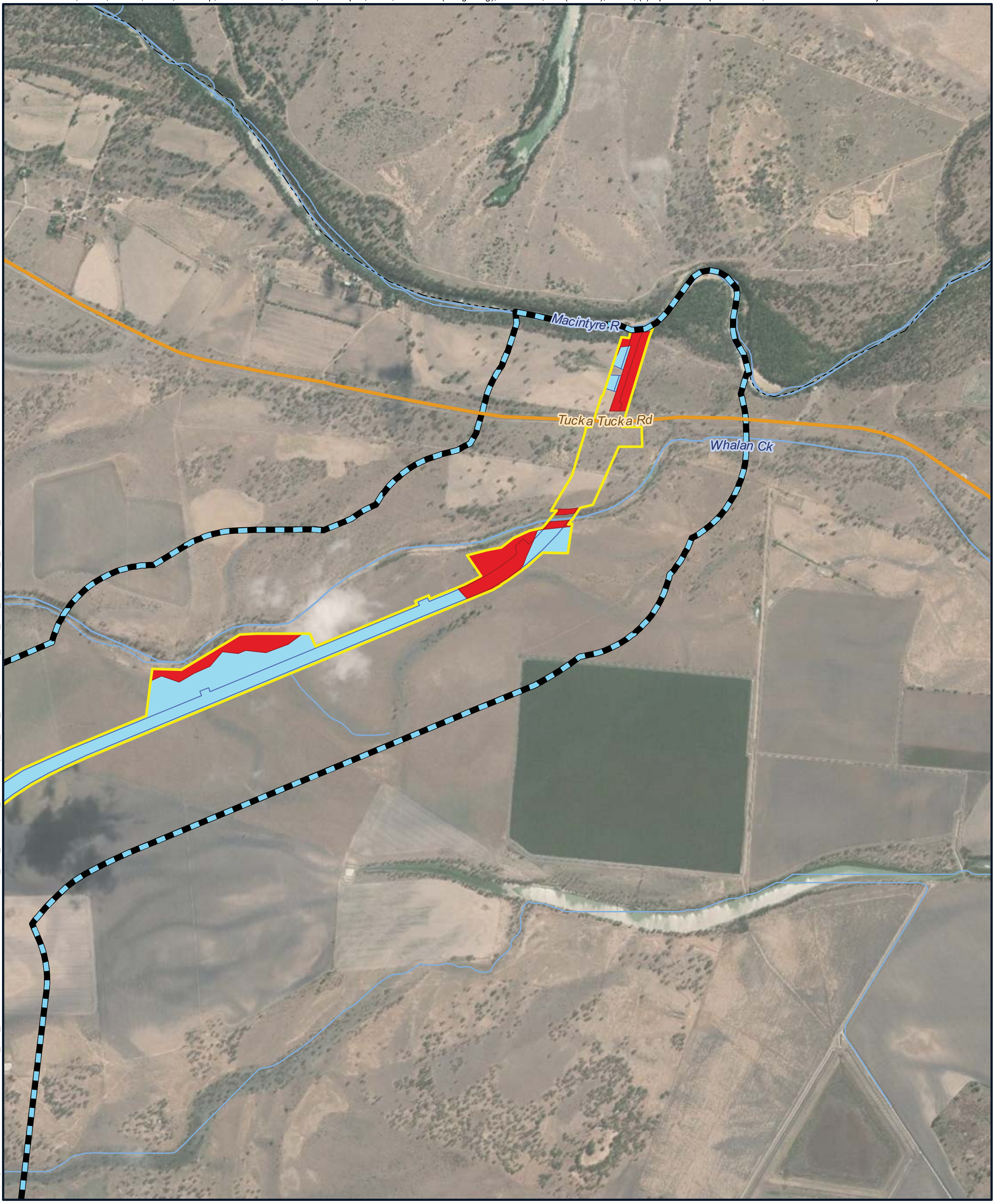

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Legend

- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Australian painted snipe (*Rostratula australis*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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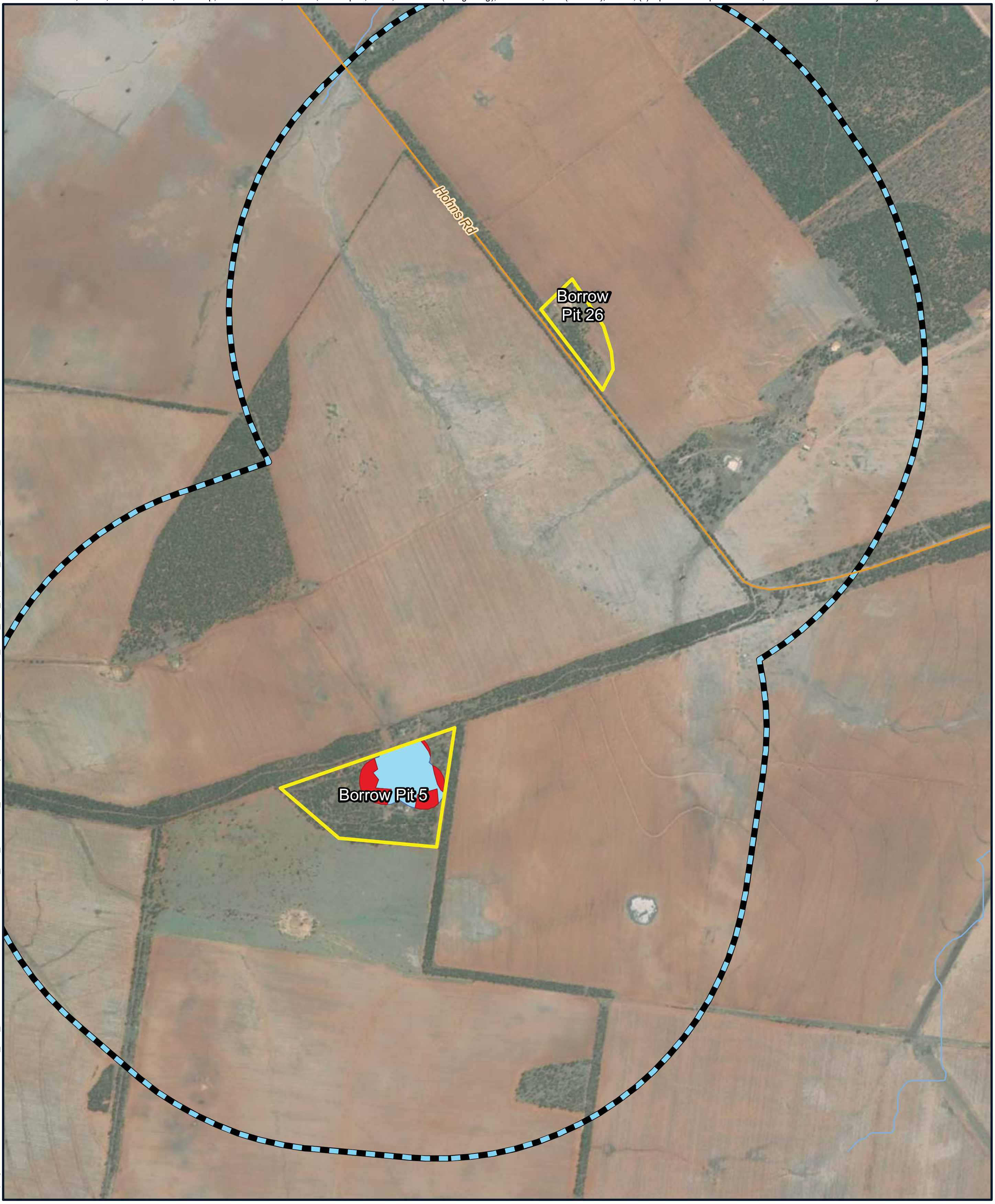

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Legend

- Subject land
- Minor roads
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

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Legend

Subject land
Minor roads
Watercourses
Study area
Subject land
Adversely impacted habitat
Not adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 14/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

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Australian painted snipe (*Rostratula australis*)

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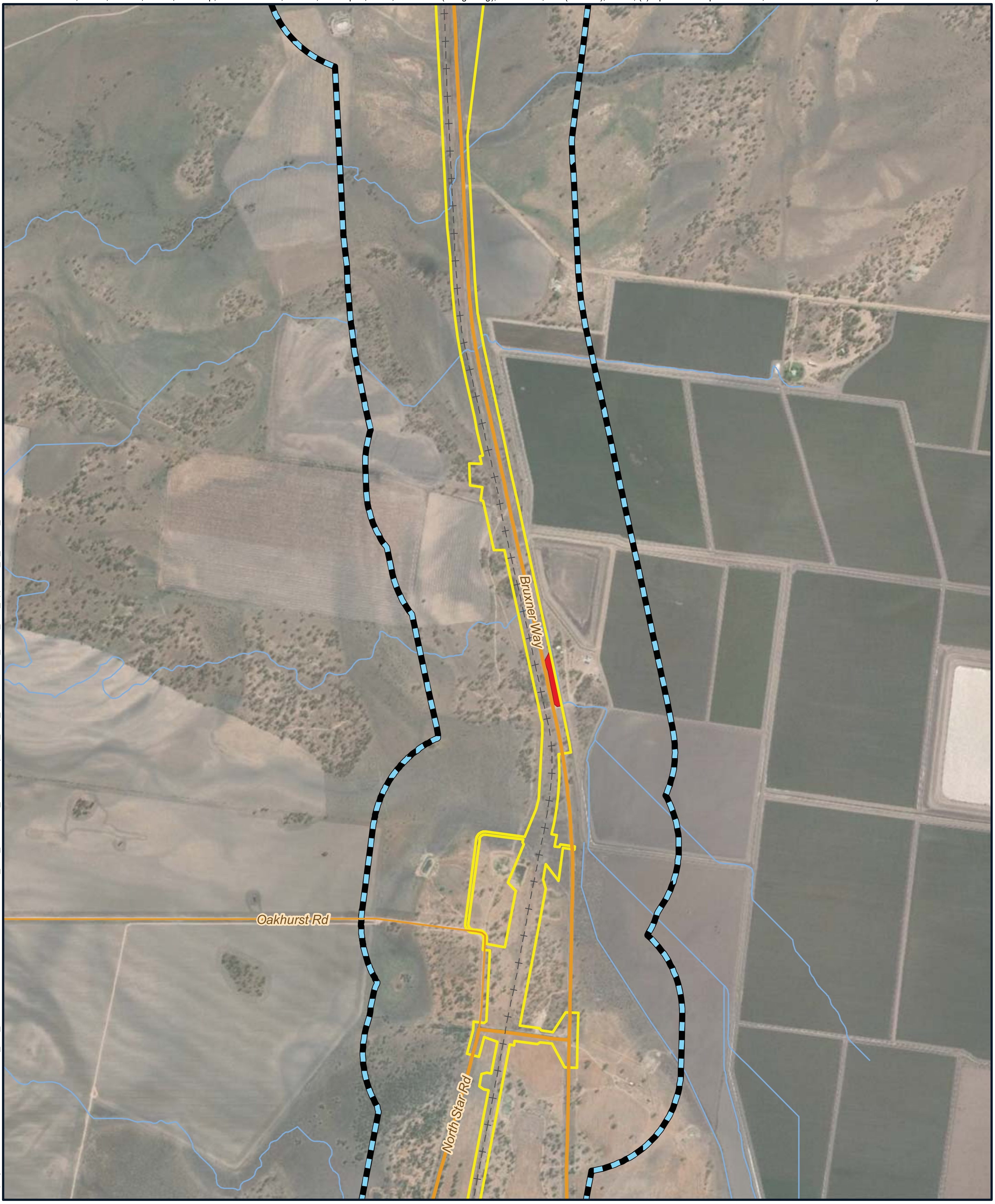

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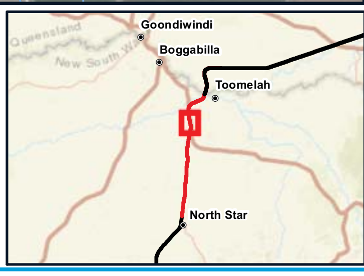
Legend

- Existing rail (non-operational)
- Major roads
- Minor roads
- Study area
- Subject land
- Adversely impacted habitat



A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

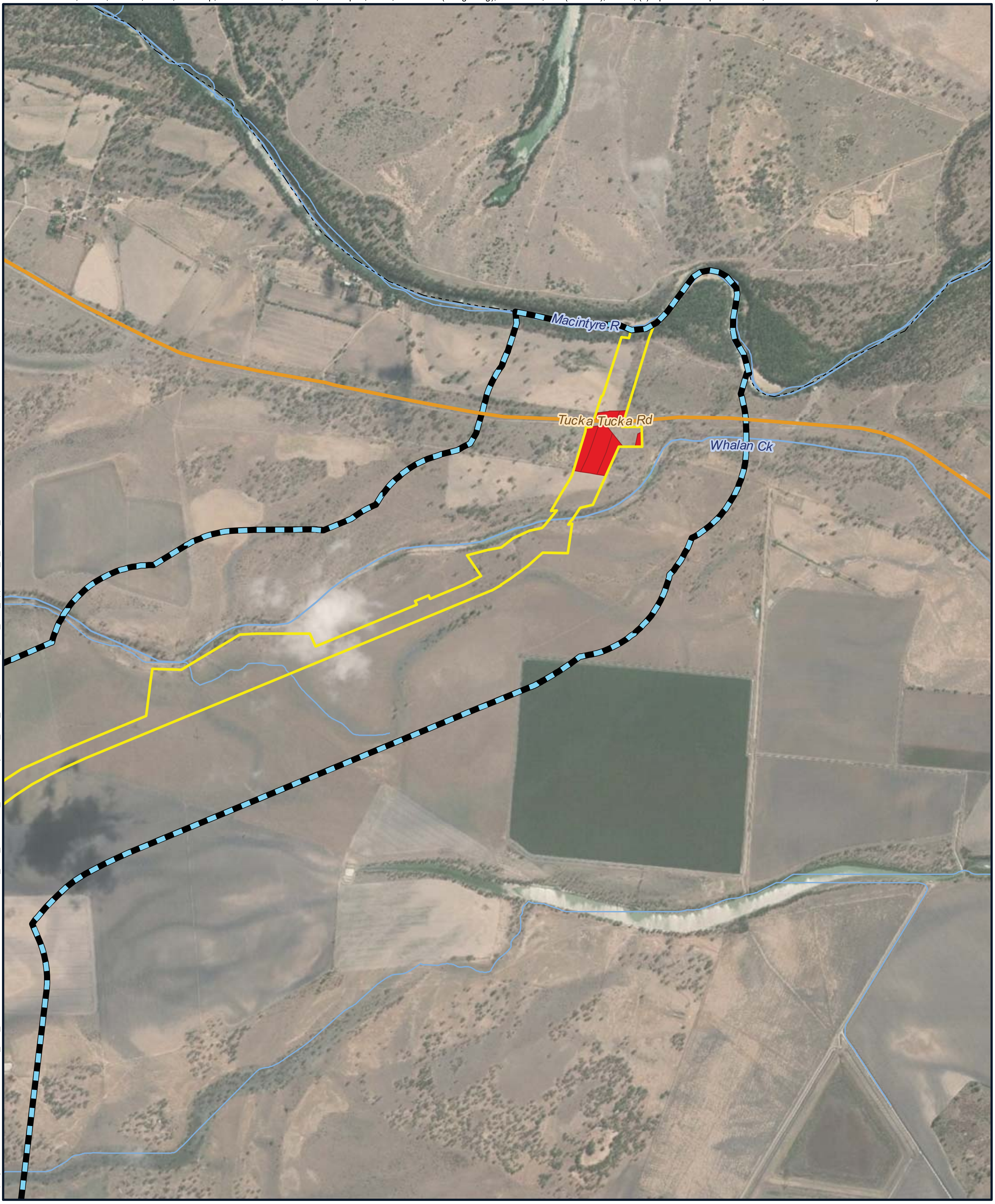
Date: 14/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output:
Border thick-tailed gecko (*Uvidocolus sphryurus*)

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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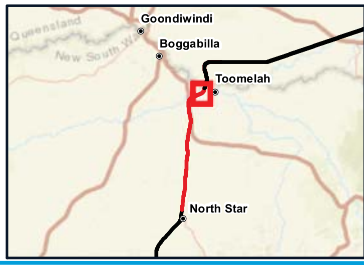
Legend

Major roads
Watercourses
Study area
Subject land
Adversely impacted habitat



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0 0.1 0.2 0.3 0.4 0.5 km

Future Freight

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Major roads
Watercourses
Study area
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Adversely impacted habitat

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0 0.1 0.2 0.3 0.4 0.5 km

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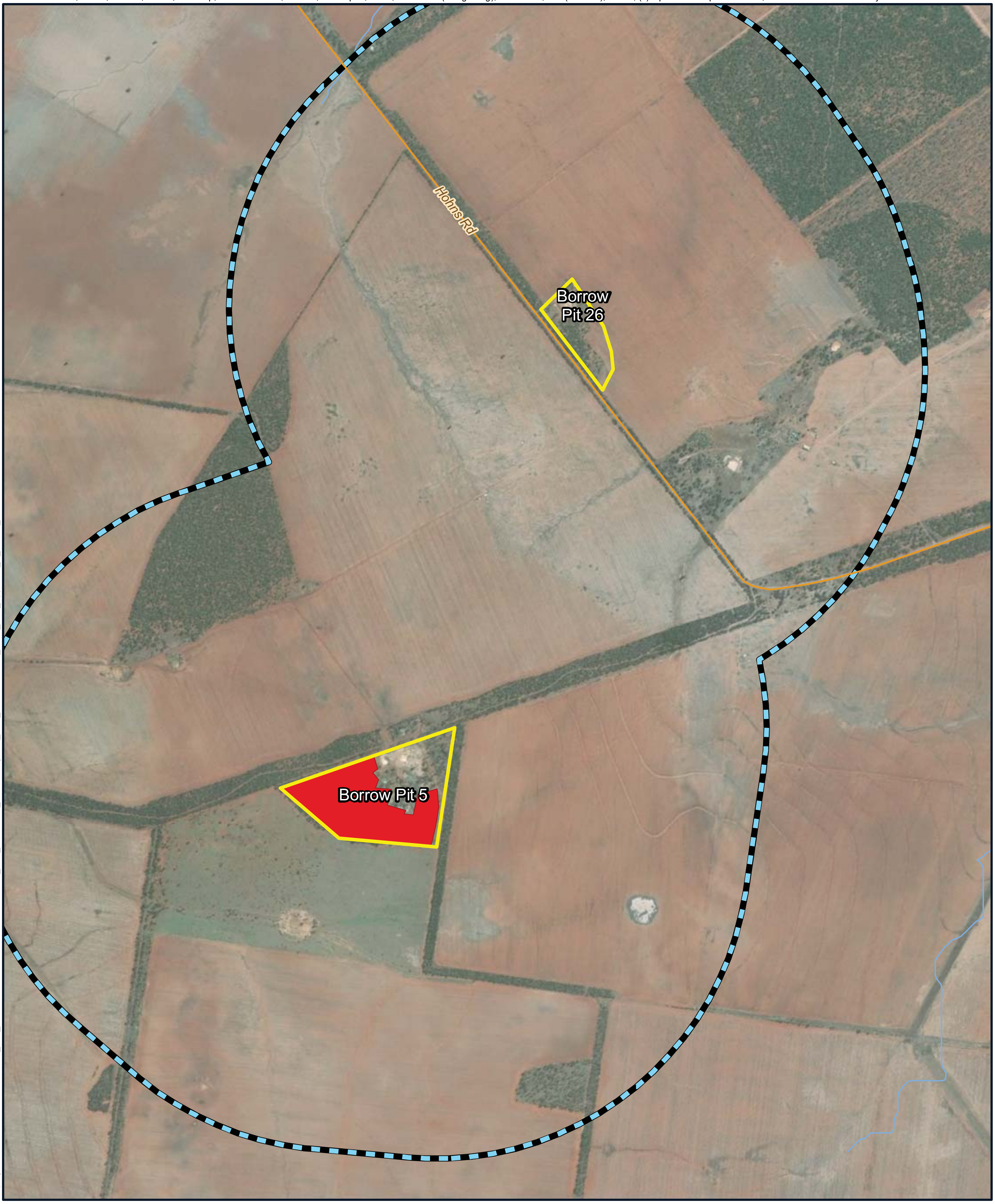

Legend

- Subject land
- Minor roads
- Study area
- Subject land
- Adversely impacted habitat

A4 scale: 1:25,000

0 0.1 0.2 0.3 0.4 0.5 km

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Border thick-tailed gecko (*Uvidocolus sphryurus*)

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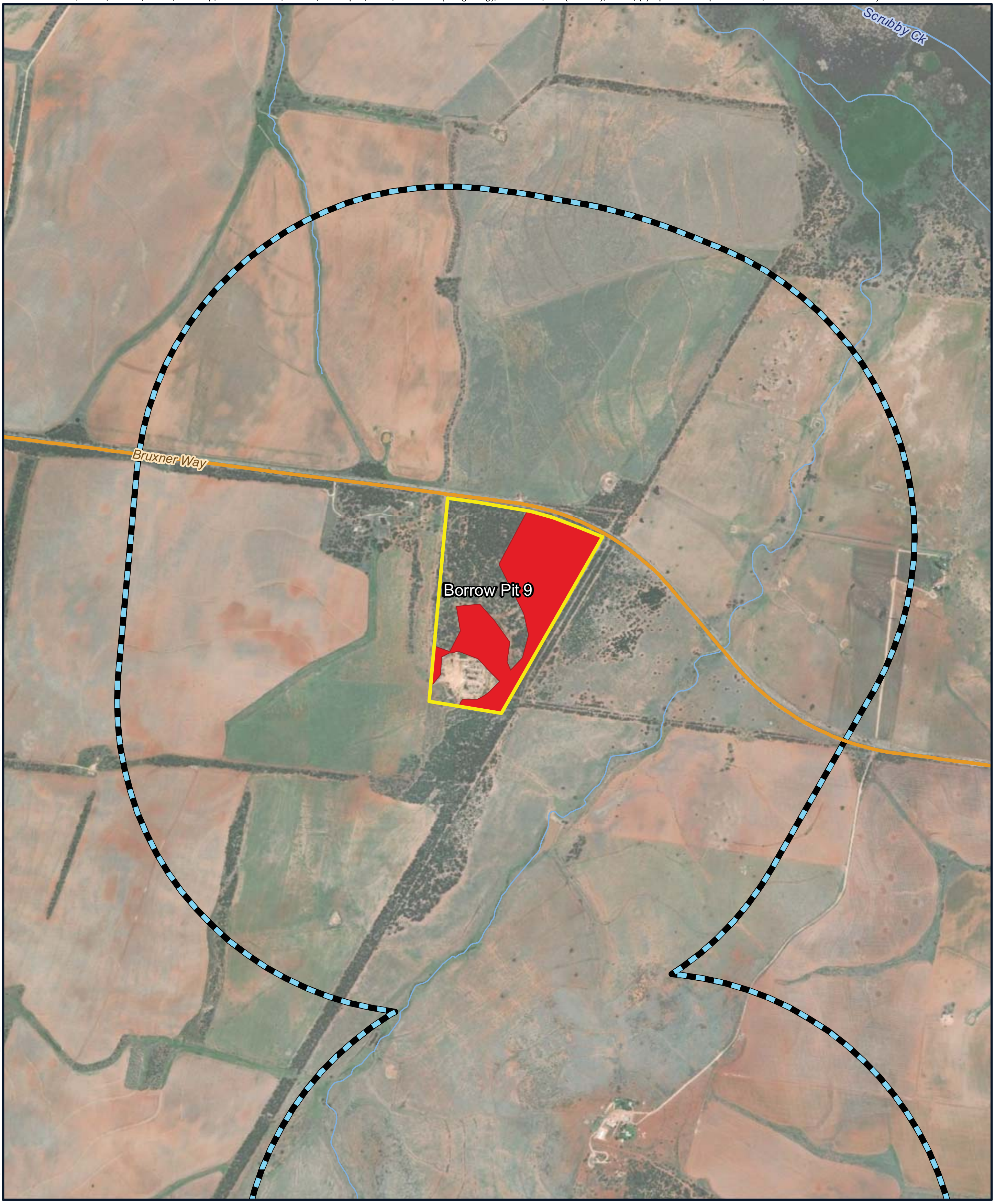

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Subject land
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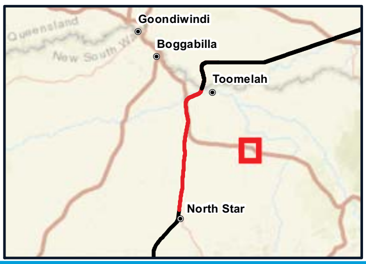

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